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Kobayashi

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(54) **WEB FORMING DEVICE, WEB PROCESSING DEVICE, FIBROUS FEEDSTOCK RECYCLING DEVICE, AND WEB FORMING METHOD**

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(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

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This patent is subject to a terminal disclaimer.

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D21F 3/02 (2006.01)
D21F 2/00 (2006.01)
D21F 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***D21F 7/06*** (2013.01); ***D21F 1/0027*** (2013.01); ***D21F 2/00*** (2013.01); ***D21F 3/02*** (2013.01)

(58) **Field of Classification Search**
USPC 162/198, 263
See application file for complete search history.

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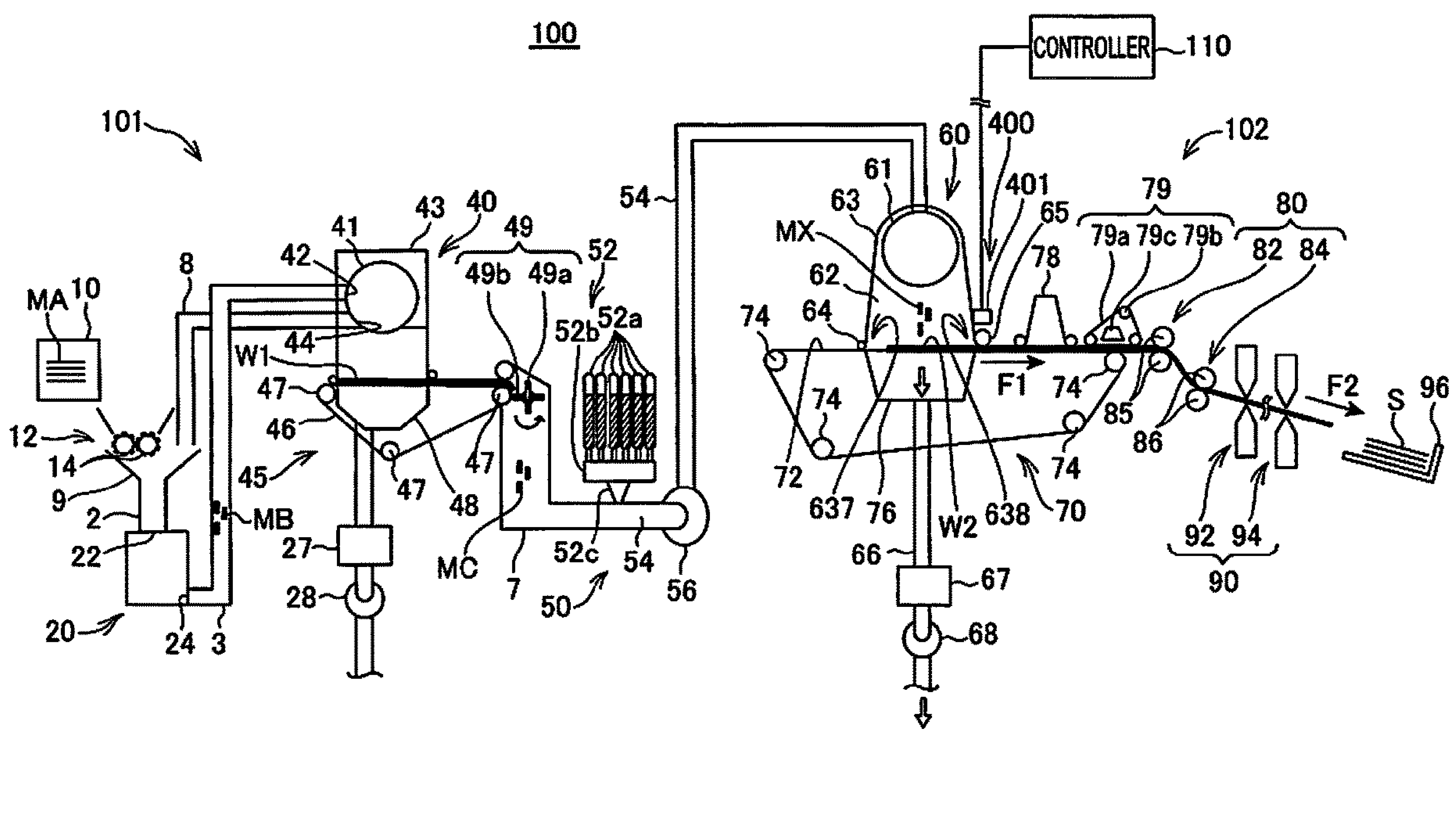
Primary Examiner — Mark Halpern
(74) *Attorney, Agent, or Firm* — Global IP Counselors, LLP

(57) **ABSTRACT**

Provided is technology enabling appropriately maintaining or adjusting the thickness of accumulated fiber when accumulating and processing fiber. A sheet manufacturing apparatus **100** has a distributor **60** that distributes a mixture MX containing fiber; a second web former **70** that forms a second web W**2**; a mesh belt **72** that conveys the second web W**2** in a conveyance direction F**1**; a roller unit **650** that compresses the second web W**2**; a measurement device **400** that measures the distribution of the thickness of the second web W**2** in a second direction intersecting the conveyance direction F**1** while the second web W**2** is being compressed by the roller unit **650**, or after the second web W**2** is compressed by the roller unit **650**; and a controller **110** that compares a measurement from the measurement device **400** with a set thickness distribution, and controls the thickness distribution of the second web W**2**.

8 Claims, 17 Drawing Sheets



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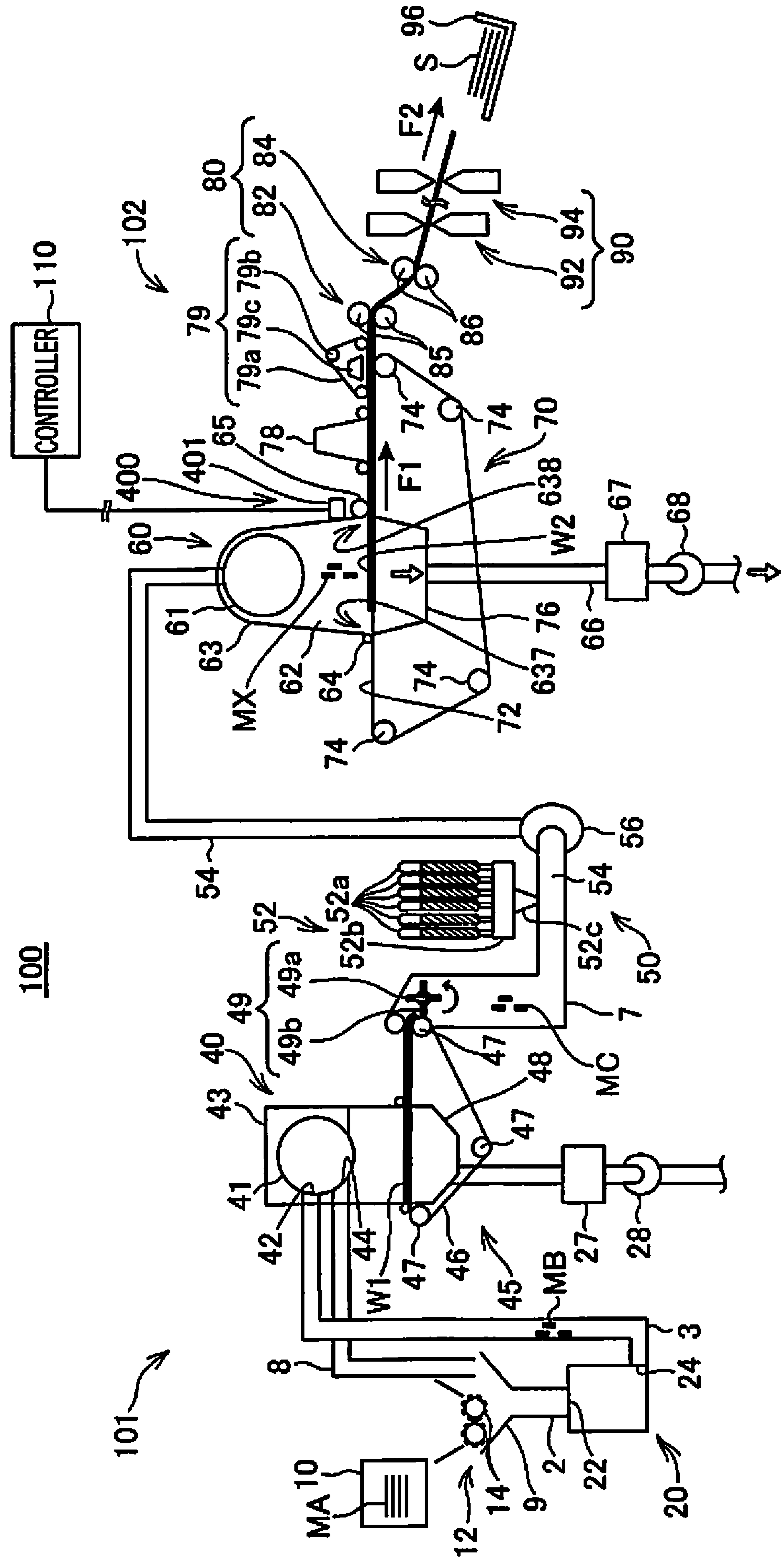


FIG. 1

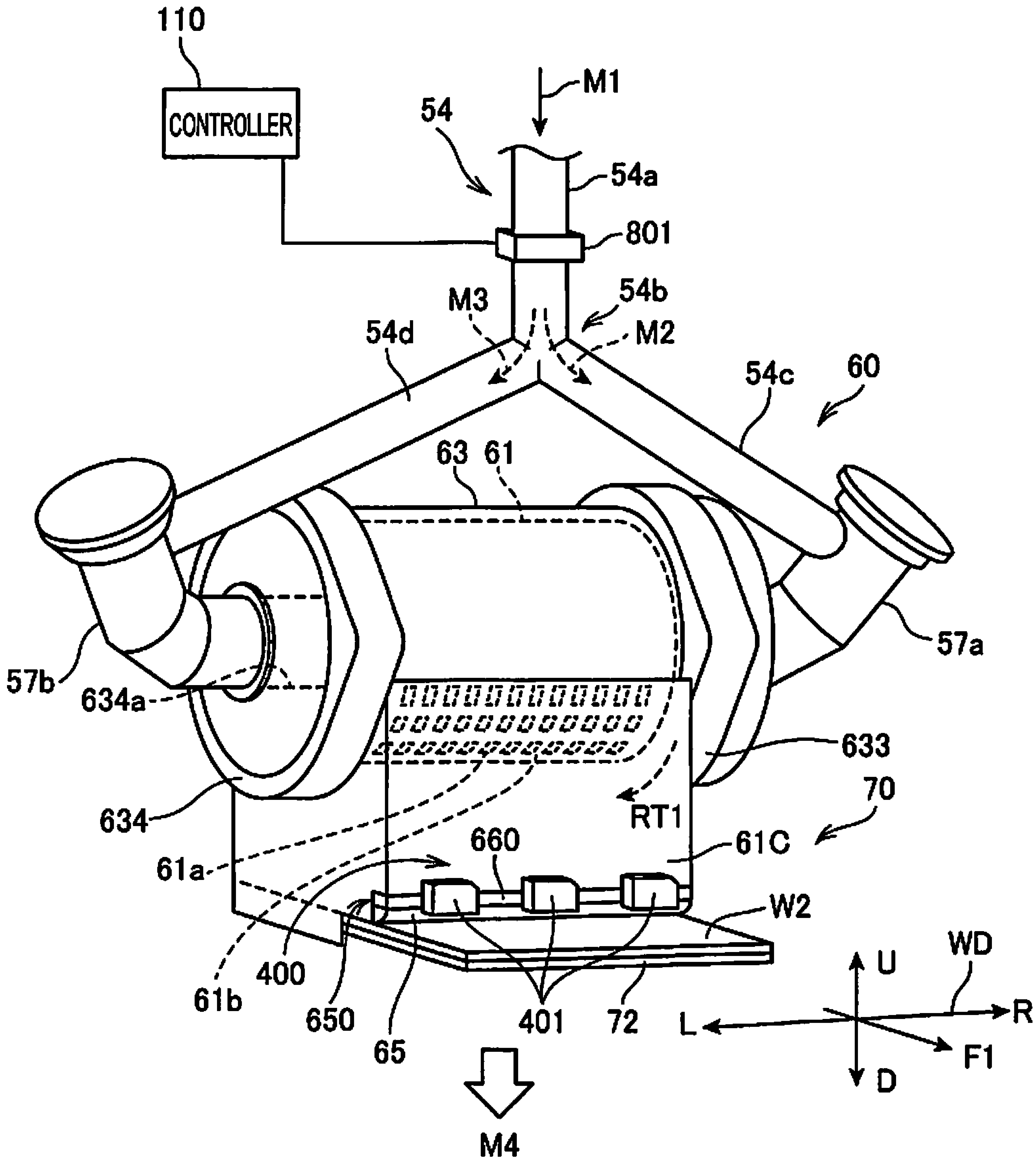
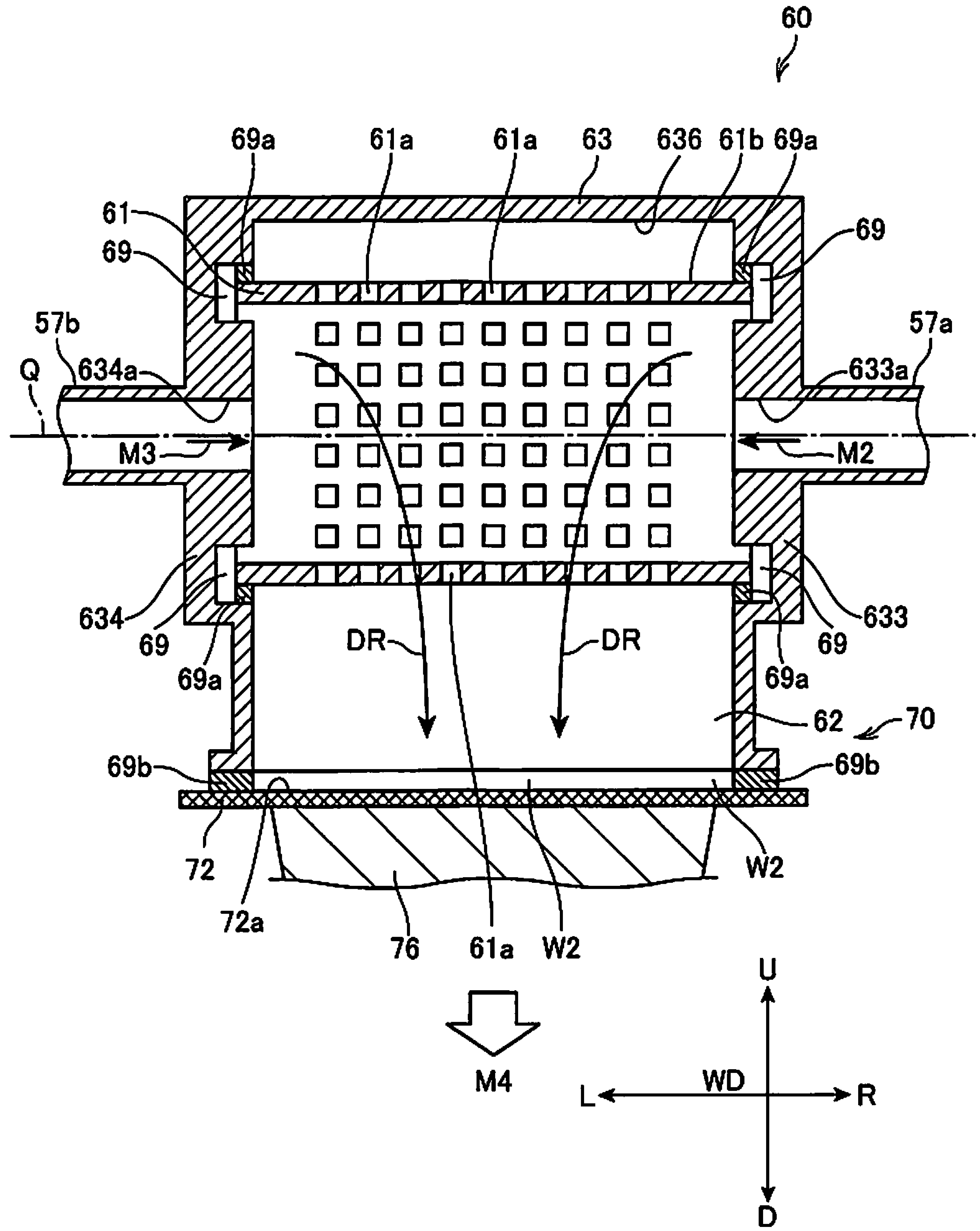

110
CONTROLLER
M1
54
54a
801
M3
54b
54d
M2
54c
60
63 61
57b
634a
57a
633
634
70
RT1
61a
660
61C
W2
61b
400
650
65
401
72
U
WD
L
R
F1
D
M4

FIG. 2


60
69a
61a
61a
63
636
61b
69a
61
69
69
57b
57a
Q
634a
633a
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M2
634
69
69a
633
69
69a
DR
DR
62
70
69b
69b
72
W2
72a
76
61a
W2
M4
U
L
WD
R
D

FIG. 3

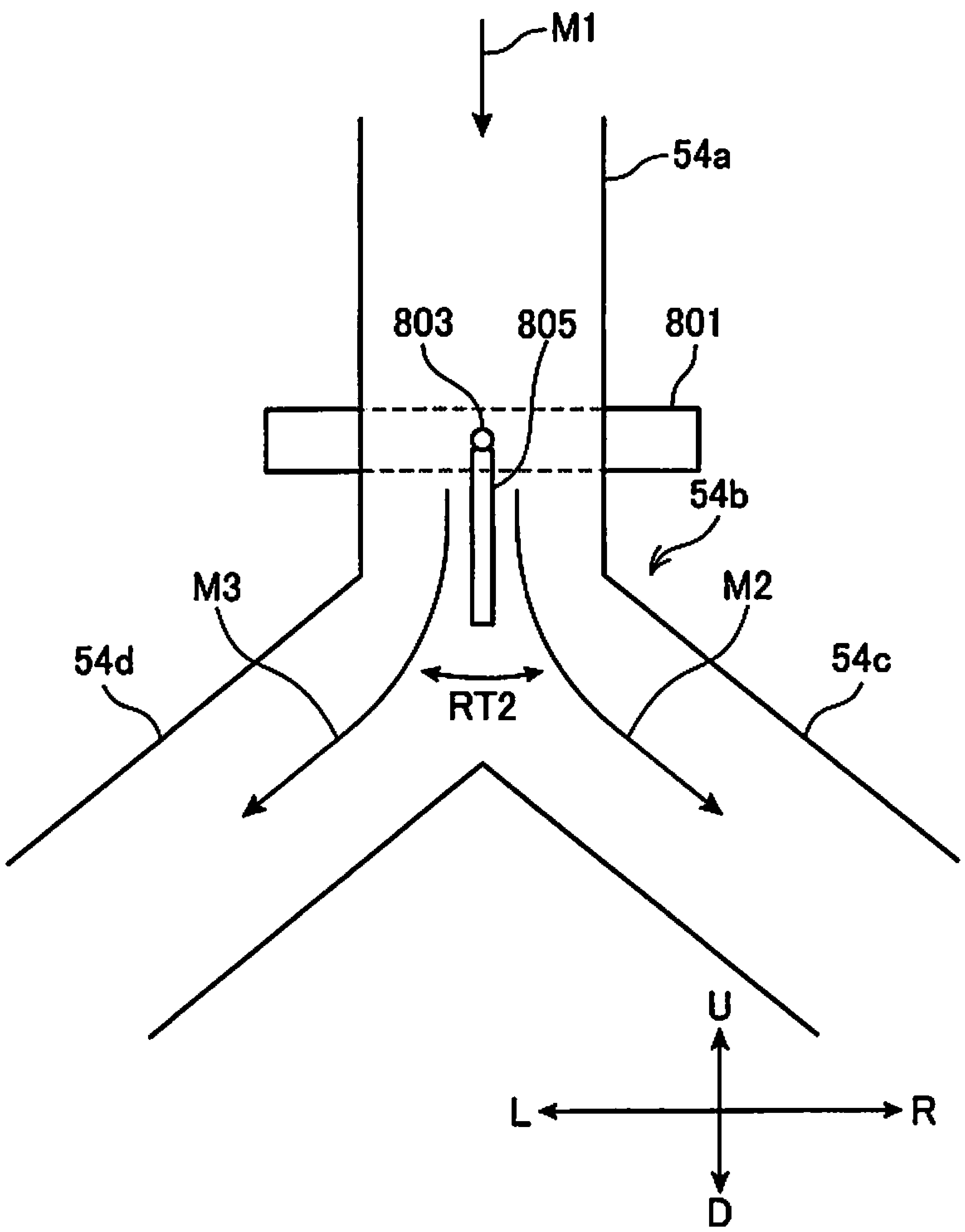


FIG. 4

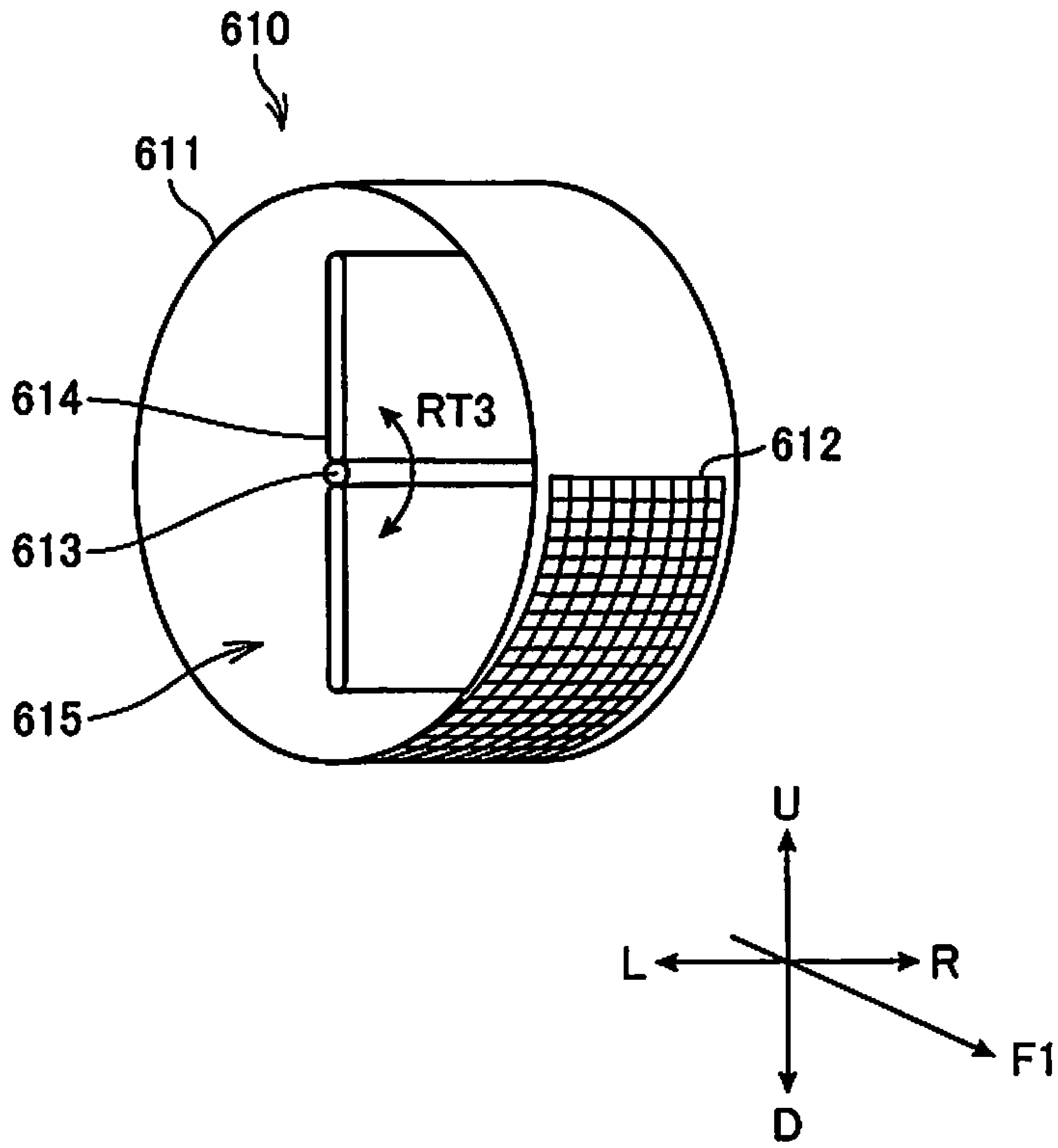


FIG. 5

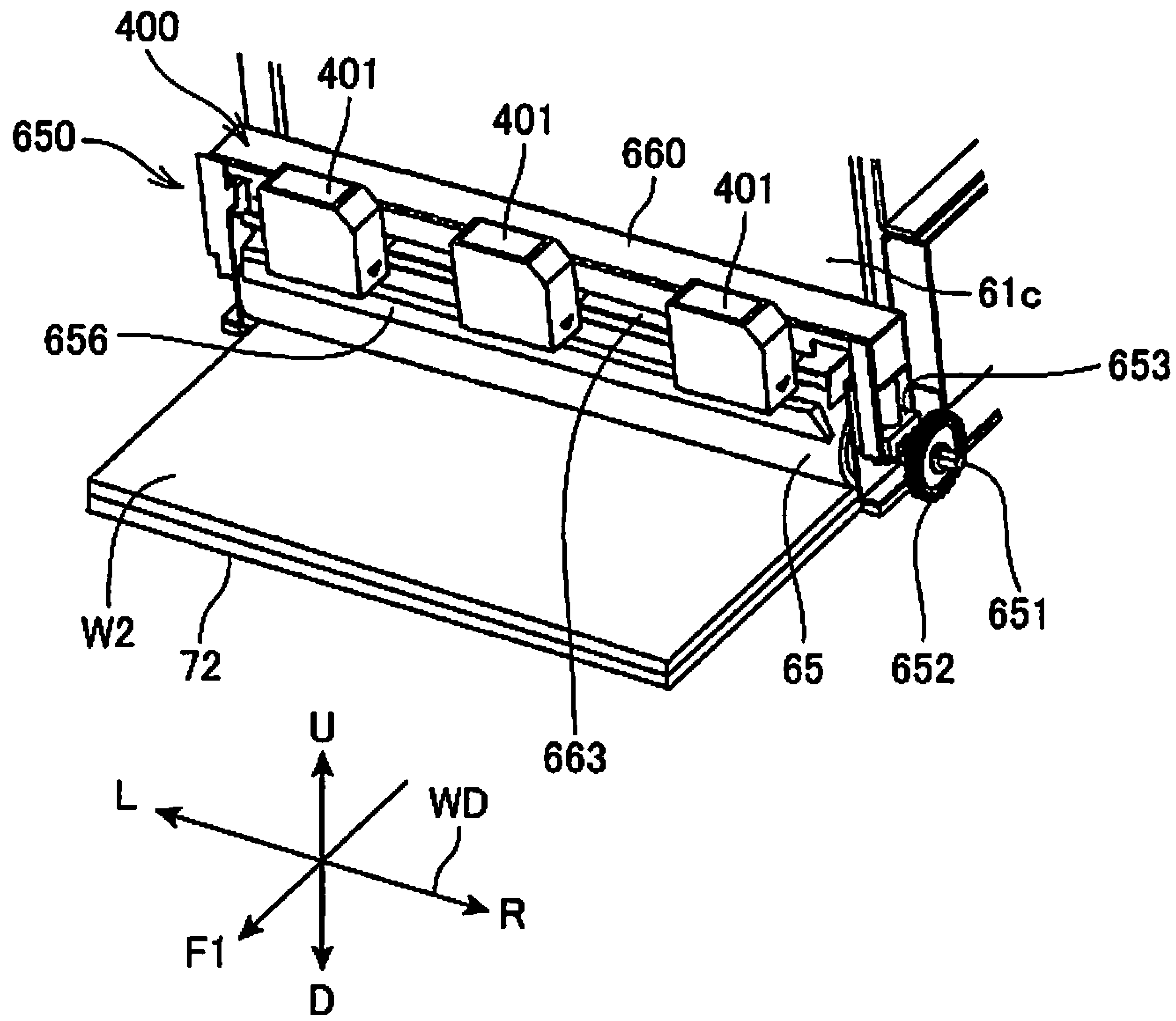

400
401
401
401
650
660
61c
656
653
651
W2
72
65
652
663
U
L
WD
R
F1
D

FIG. 6

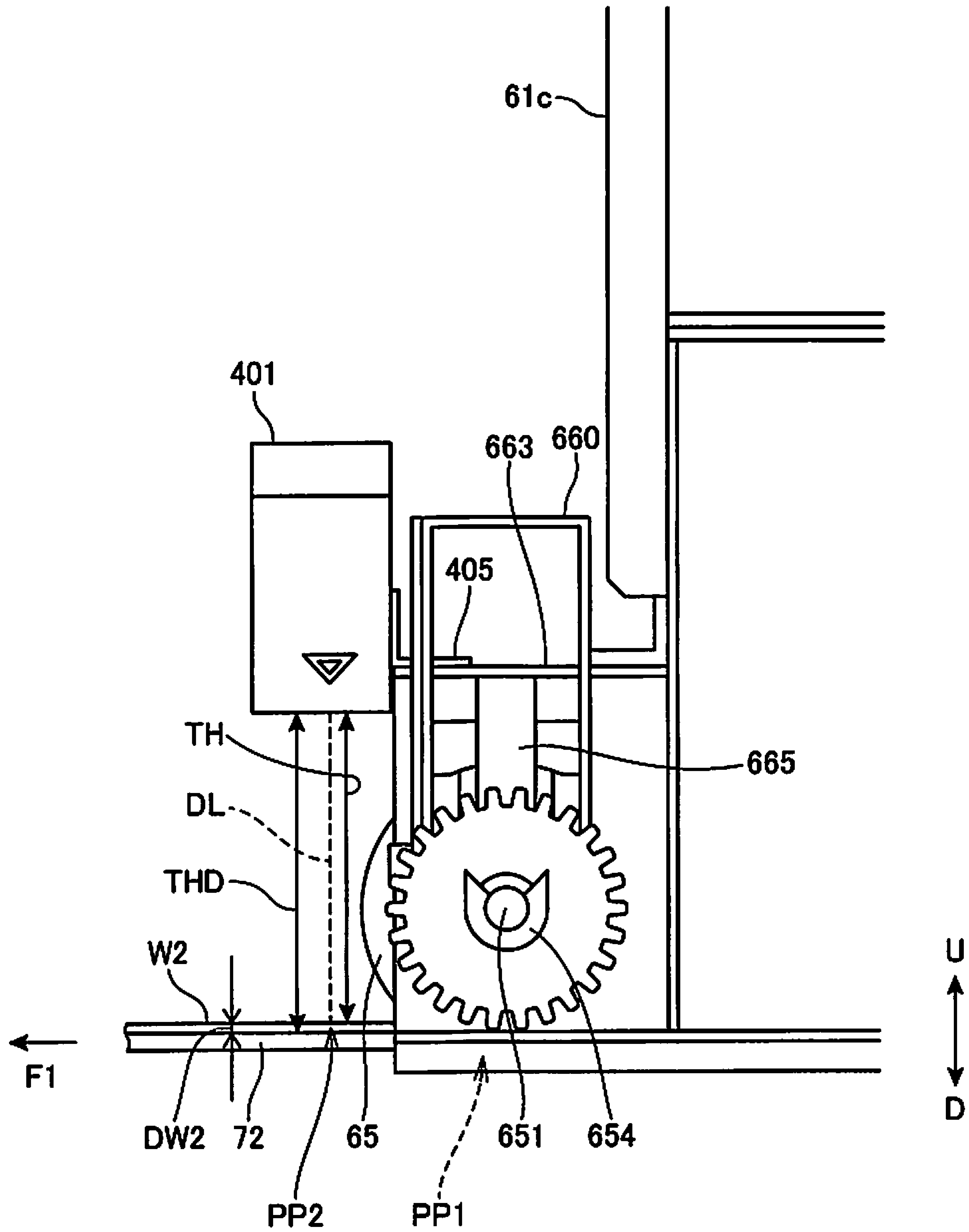

61c
401
663
660
405
665
TH
DL
THD
W2
U
D
F1
DW2
72
65
651
654
PP2
PP1

FIG. 7

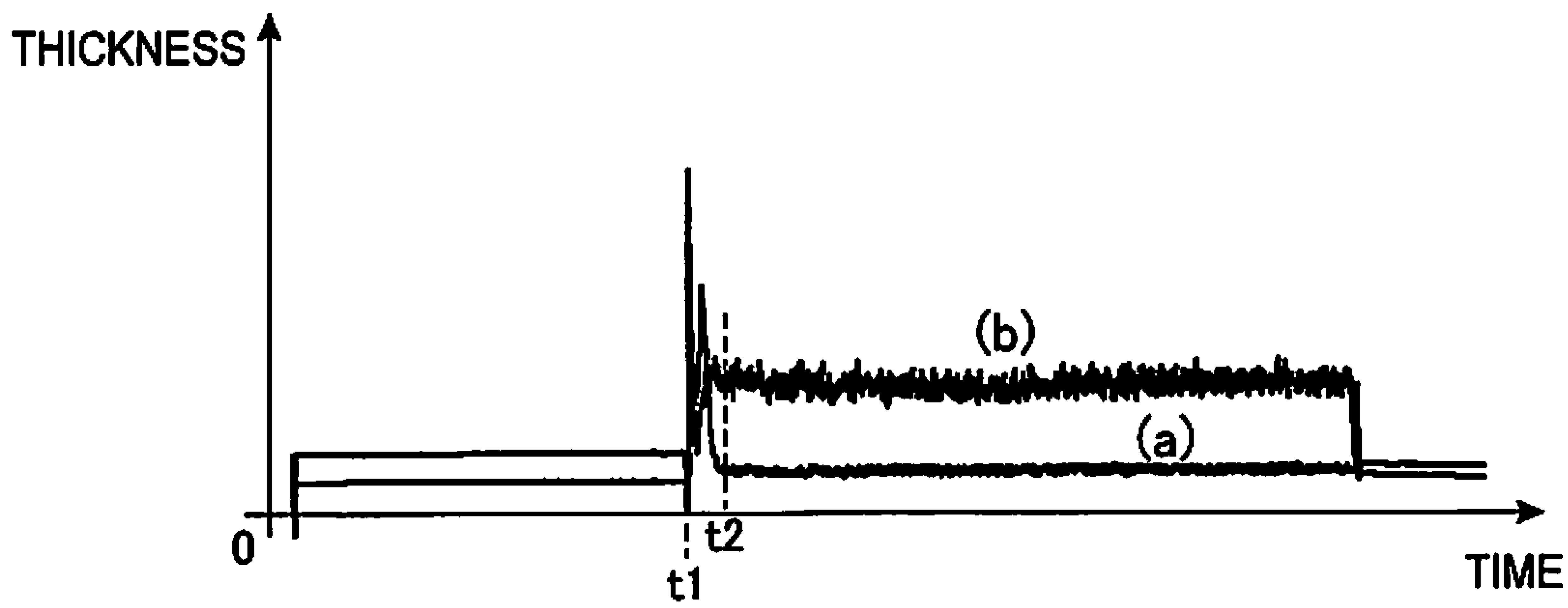
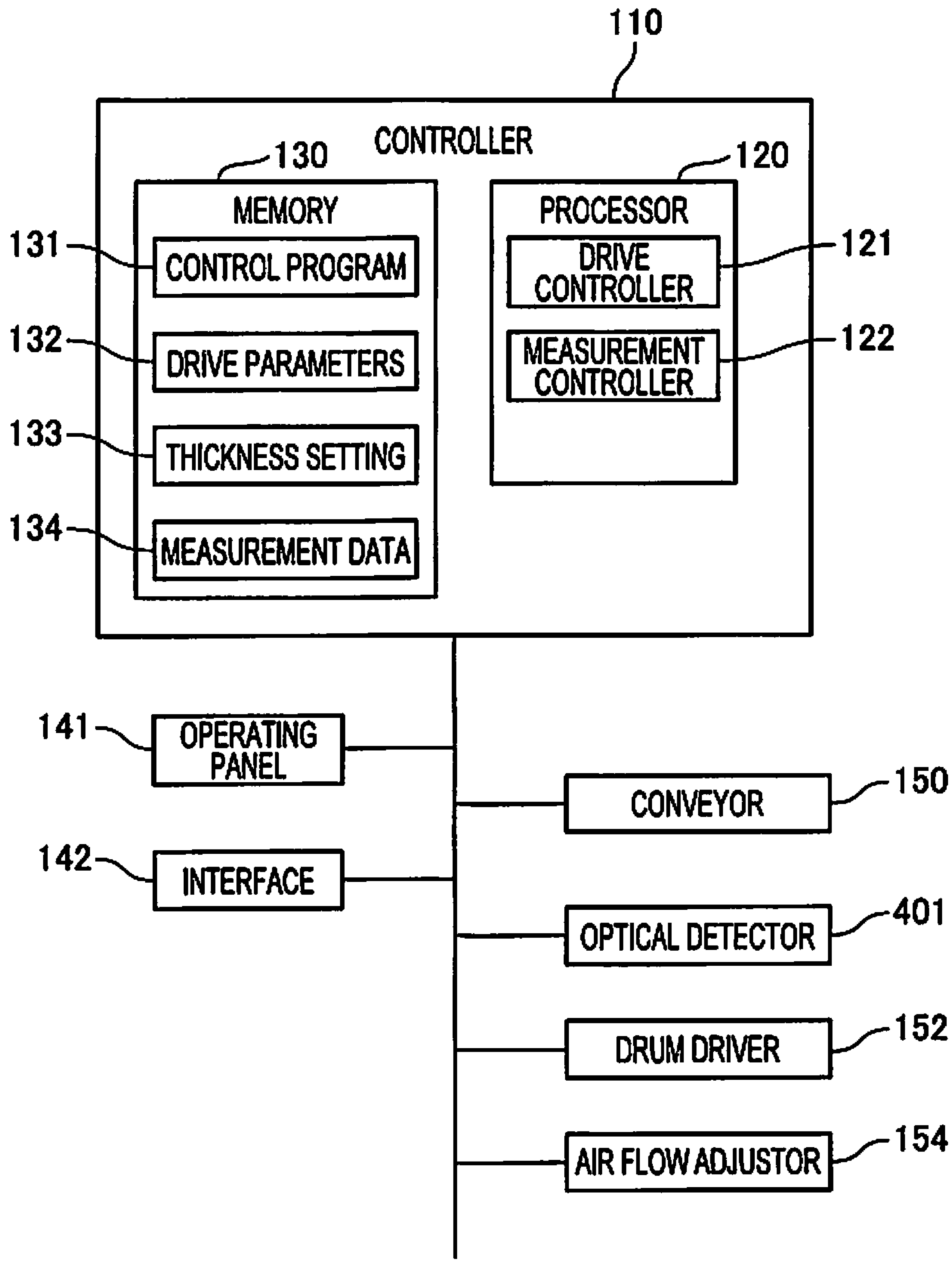


FIG. 8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CONTROLLER
130
MEMORY
131
CONTROL PROGRAM
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DRIVE PARAMETERS
133
THICKNESS SETTING
134
MEASUREMENT DATA
120
PROCESSOR
DRIVE CONTROLLER
121
MEASUREMENT CONTROLLER
122
141
OPERATING PANEL
142
INTERFACE
CONVEYOR
150
OPTICAL DETECTOR
401
DRUM DRIVER
152
AIR FLOW ADJUSTOR
154

FIG. 9

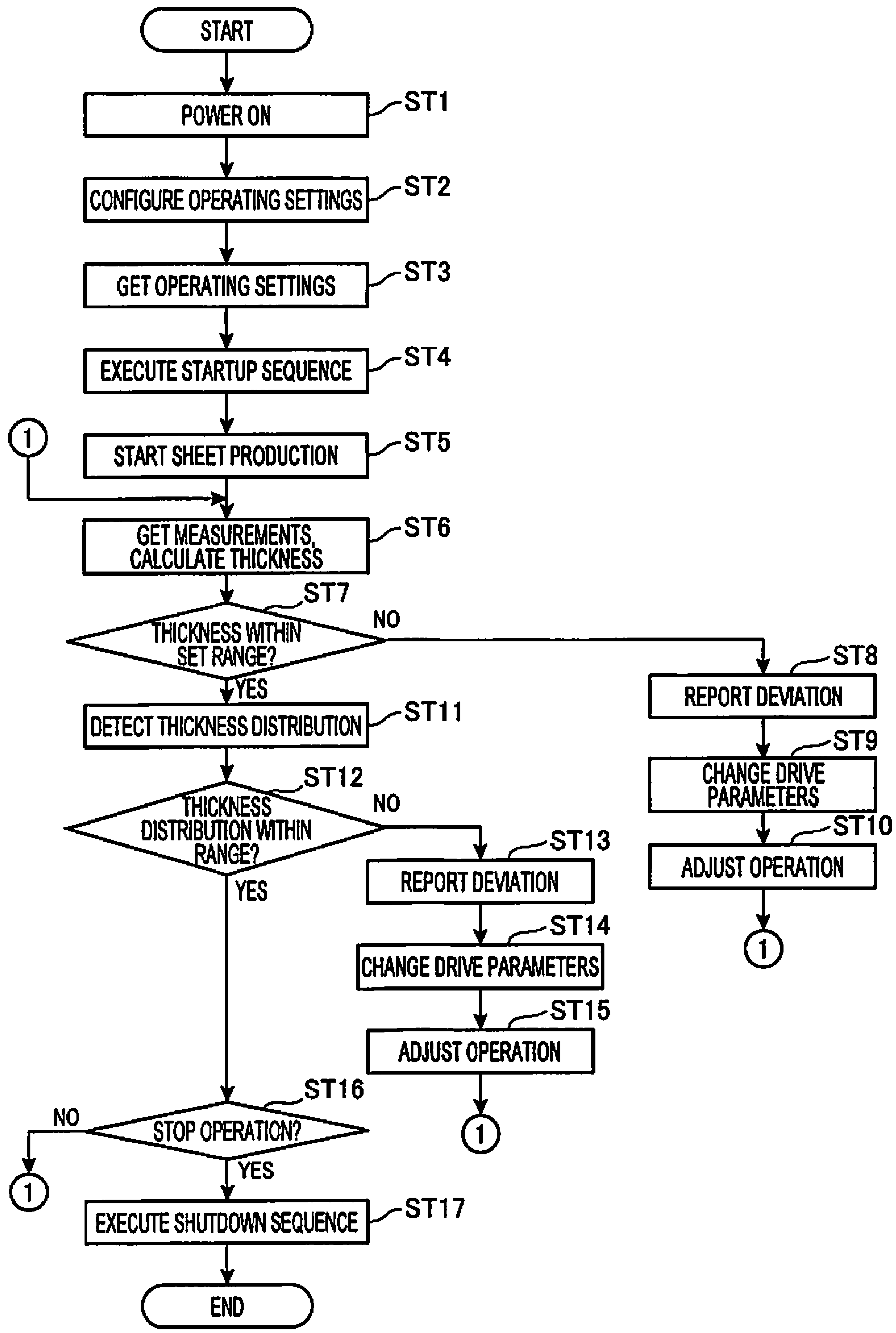
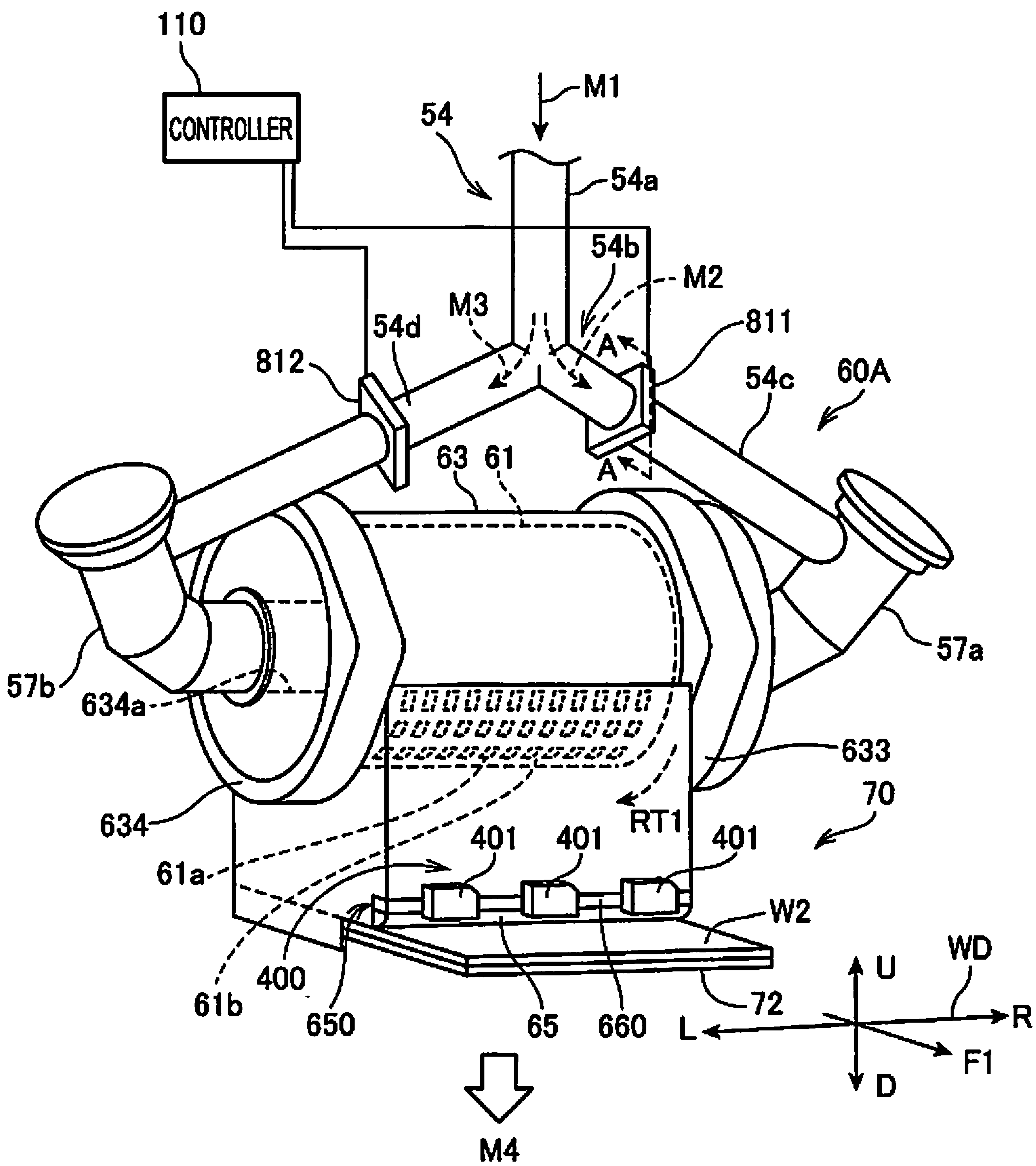

START
POWER ON
ST1
CONFIGURE OPERATING SETTINGS
ST2
GET OPERATING SETTINGS
ST3
EXECUTE STARTUP SEQUENCE
ST4
START SHEET PRODUCTION
ST5
1
GET MEASUREMENTS, CALCULATE THICKNESS
ST6
THICKNESS WITHIN SET RANGE?
ST7
NO
YES
REPORT DEVIATION
ST8
CHANGE DRIVE PARAMETERS
ST9
ADJUST OPERATION
ST10
1
DETECT THICKNESS DISTRIBUTION
ST11
THICKNESS DISTRIBUTION WITHIN RANGE?
ST12
NO
YES
REPORT DEVIATION
ST13
CHANGE DRIVE PARAMETERS
ST14
ADJUST OPERATION
ST15
1
STOP OPERATION?
ST16
NO
1
YES
EXECUTE SHUTDOWN SEQUENCE
ST17
END

FIG. 10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CONTROLLER
M1
54
54a
54b
M2
M3
54d
812
811
A
A
54c
60A
63 61
57a
57b
634a
633
634
70
RT1
401
401
401
61a
W2
400
WD
U
61b
650
65
660
72
L
R
F1
D
M4

FIG. 11

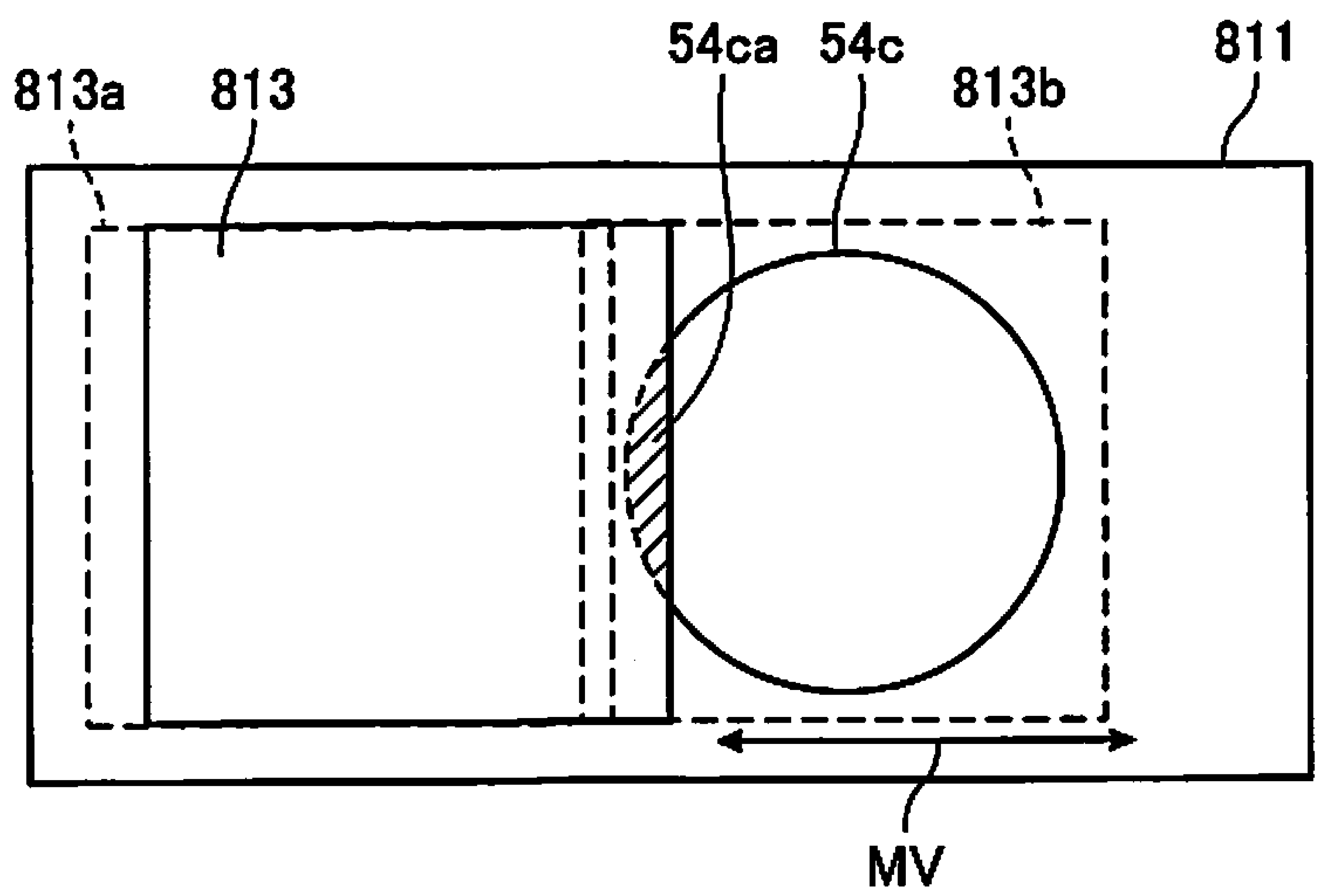
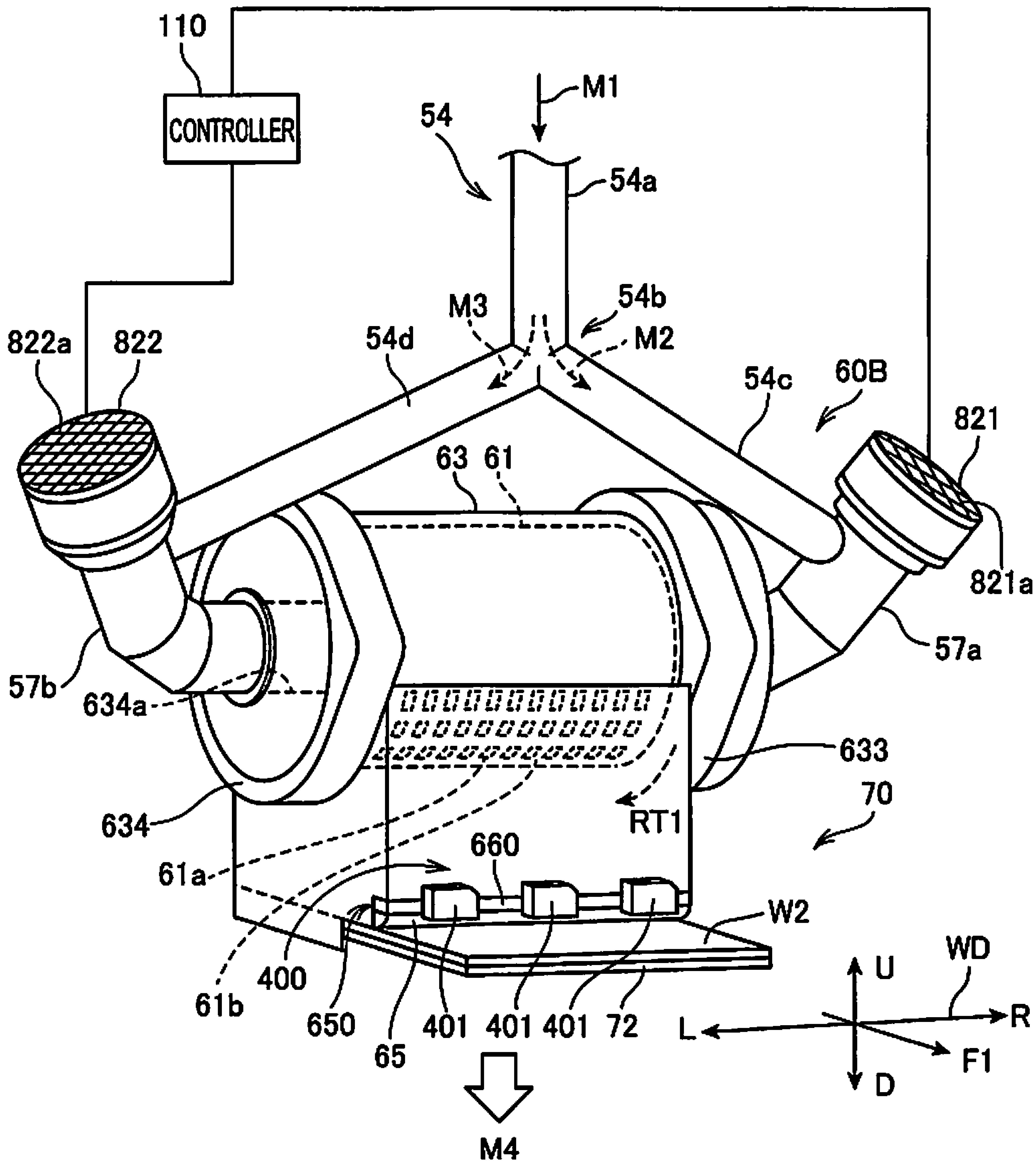


FIG. 12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CONTROLLER
M1
54
54a
54b
M3
M2
54d
54c
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822a
822
821
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57a
57b
634a
633
70
RT1
634
660
61a
W2
400
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R
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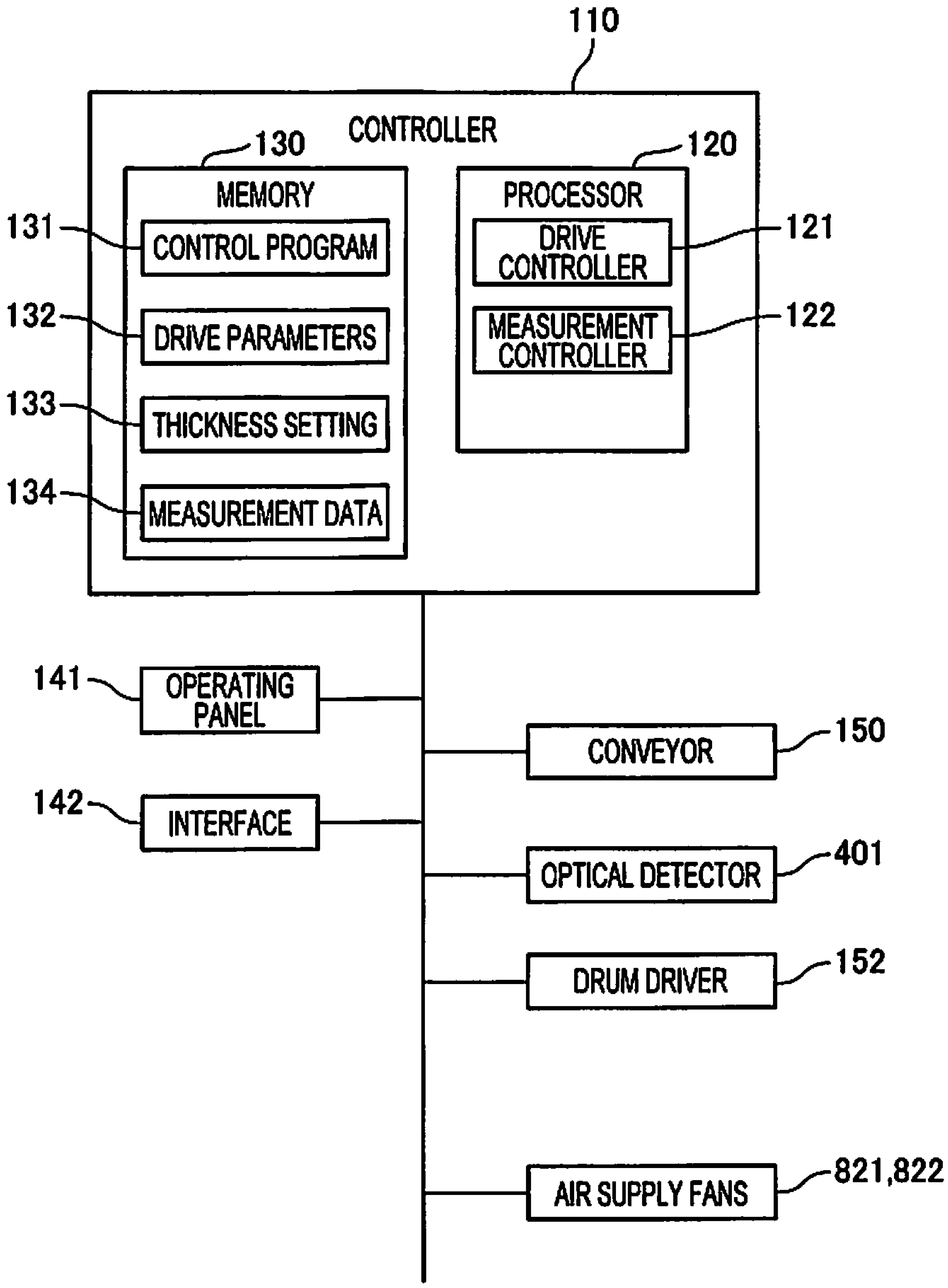
D
M4

FIG. 13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DRIVE PARAMETERS
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THICKNESS SETTING
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DRIVE CONTROLLER
121
MEASUREMENT CONTROLLER
122
141
OPERATING PANEL
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INTERFACE
CONVEYOR
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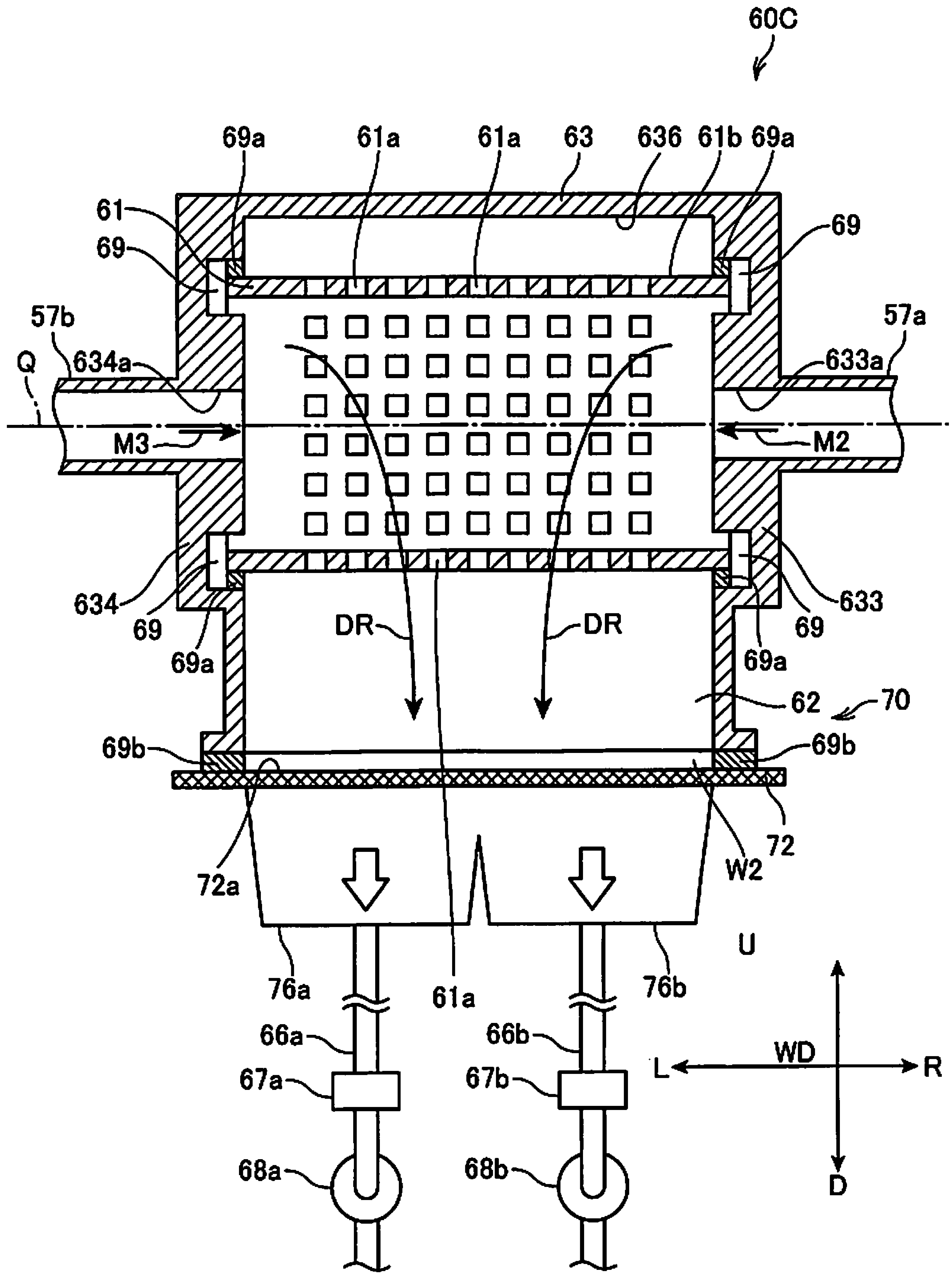
OPTICAL DETECTOR
401
DRUM DRIVER
152
AIR SUPPLY FANS
821,822

FIG. 14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634a
633a
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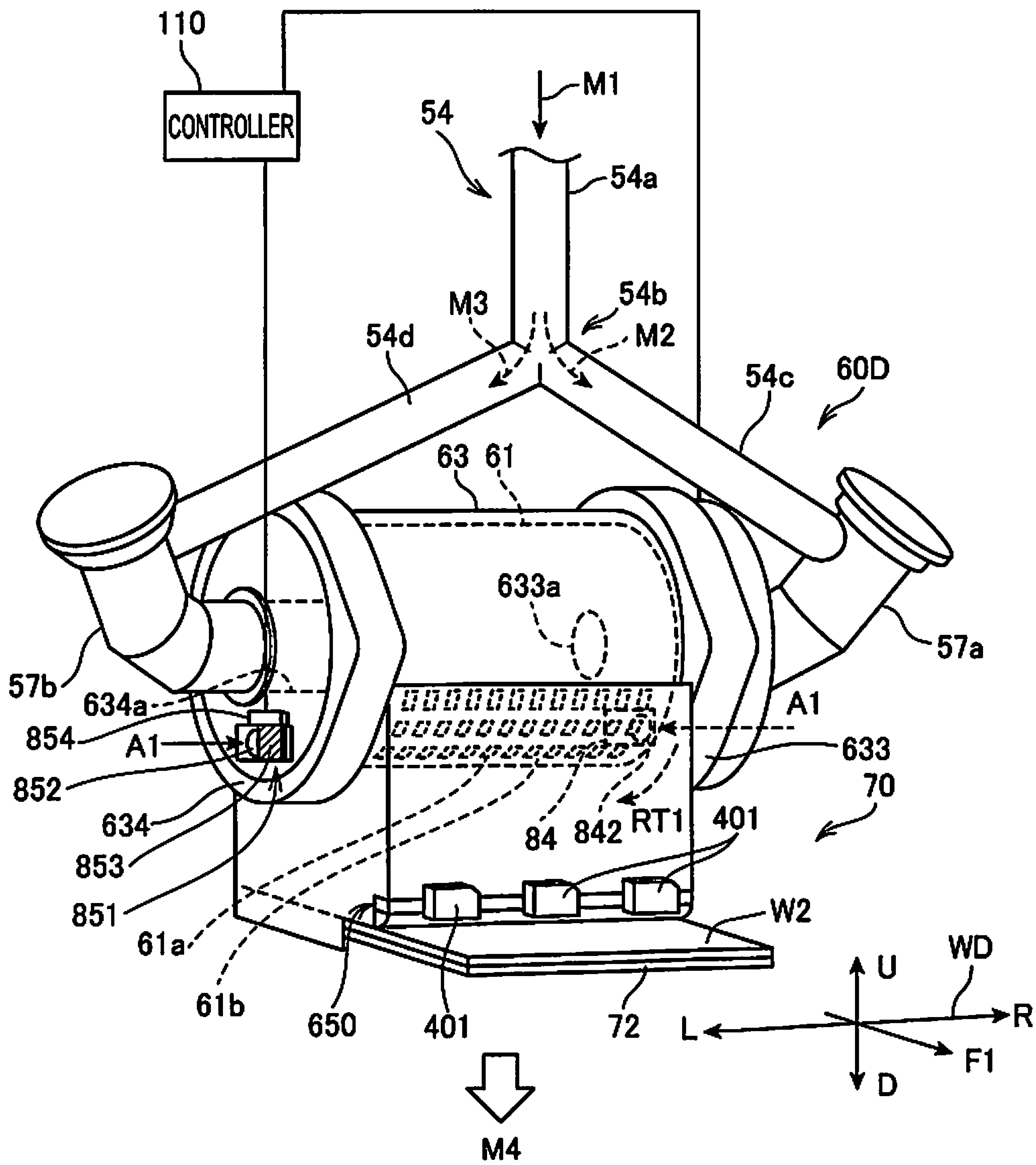
M2
634
69
69a
633
69
69a
DR
DR
62
70
69b
69b
72a
W2
72
76a
61a
76b
U
66a
66b
67a
67b
L
WD
R
68a
68b
D

FIG. 15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M1
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54a
54b
M3
M2
54d
54c
60D
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854
A1
852
634
853
851
61a
61b
A1
633
70
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RT1
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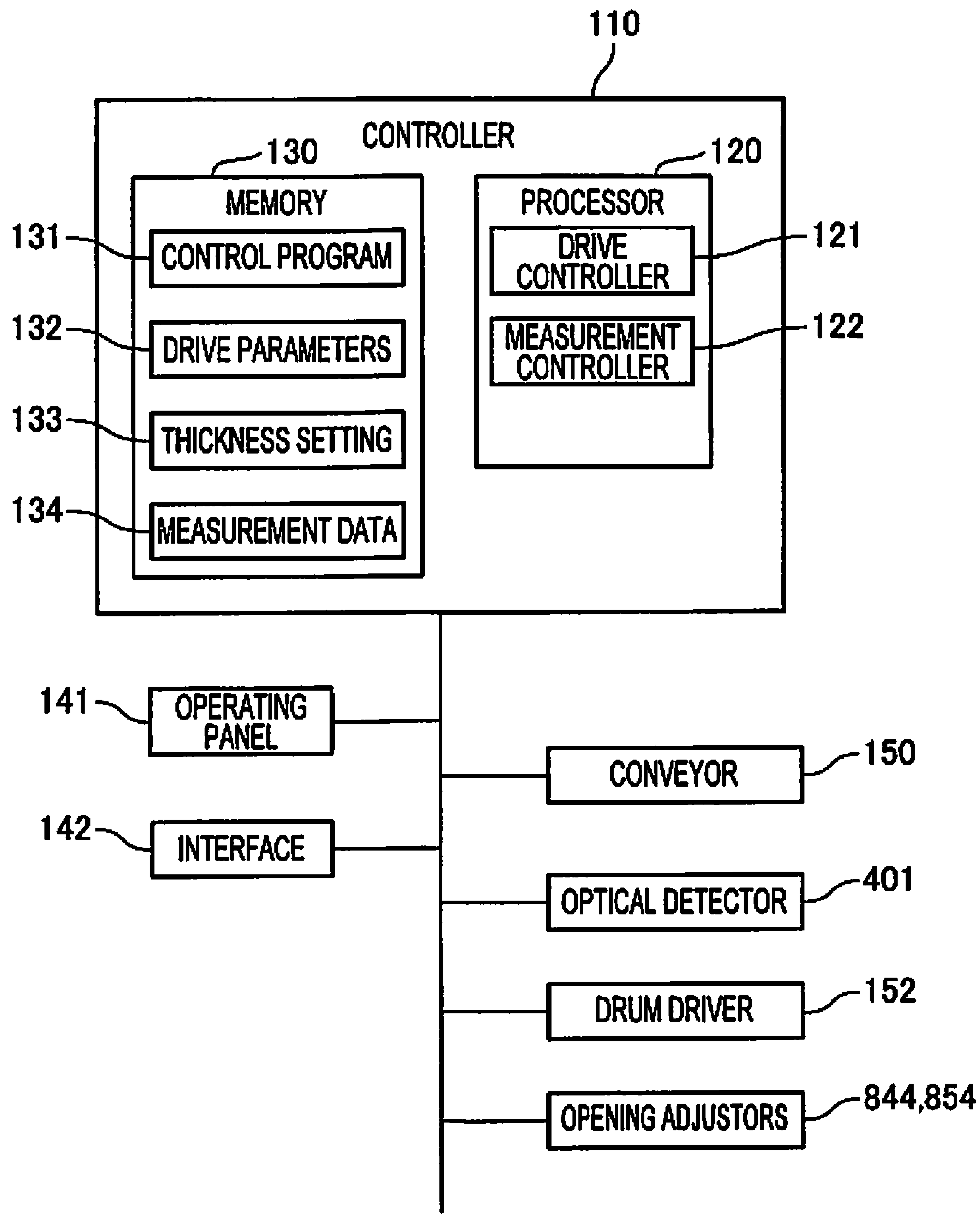
W2
650
401
72
U
WD
L
R
F1
D
M4

FIG. 16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MEASUREMENT DATA
DRIVE CONTROLLER
121
MEASUREMENT CONTROLLER
122
141
OPERATING PANEL
142
INTERFACE
CONVEYOR
150
OPTICAL DETECTOR
401
DRUM DRIVER
152
OPENING ADJUSTORS
844,854

FIG. 17

WEB FORMING DEVICE, WEB PROCESSING DEVICE, FIBROUS FEEDSTOCK RECYCLING DEVICE, AND WEB FORMING METHOD

BACKGROUND

1. Technical Field

The present invention relates to a web forming device, a web processing device, a fibrous feedstock recycling device, and a web forming method.

This application is based upon Japanese Patent Application 2018-128782 filed on Jul. 6, 2018, the entire contents of which are incorporated by reference herein.

2. Related Art

Devices for processing paper fiber are known from the literature. See, for example, JP-A-H7-3603. The device disclosed in JP-A-H7-3603 forms a mat by spraying a mixture of recovered paper fiber and binder onto a screen. The mat is then processed into a molded product of recovered paper fiber by applying pressure and heat.

Methods of measuring the thickness of a formed product by detecting the reflection of light emitted to the object of which the thickness is to be measured are known from the literature. See, for example, JP-T-2012-504752. An advantage of the method disclosed in JP-A-H7-3603 is that thickness can be measured without touching the workpiece being measured.

In a device that accumulates and processes fiber as described in JP-A-H7-3603, the thickness of the accumulated fiber is preferably maintained at a desirable level. However, measuring the thickness of the accumulated fiber is not simple. For example, when using the method described in JP-T-2012-504752, significant variation can occur in the measured thickness because of peaks and valleys (roughness) in the surface of the fiber mat. Therefore, when accumulating and processing fiber, adjusting the thickness of the accumulating fiber is difficult.

SUMMARY

An object of the present invention is to provide technology enabling maintaining or adjusting the thickness of the accumulated fiber to an appropriate thickness when accumulating and processing fiber.

To achieve the foregoing objective, a web forming device according to one aspect of the invention includes a distributor configured to disperse material containing fiber; an accumulator configured to accumulate the material dispersed by the distributor and form a web; a conveyor configured to convey the web in a first direction; a compression device configured to compress the web conveyed in the first direction; a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the compression device, or after the web is compressed by the compression device; and a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web.

In another aspect of the invention, the web forming device also has a plurality of measurement devices disposed along the second direction.

In another aspect of the invention, the web forming device also has a plurality of material suppliers that supply the material to the distributor; and an adjustor configured to adjust an amount of the material supplied to the distributor from the plurality of suppliers as controlled by the controller.

In a web forming device according to another aspect of the invention, the distributor has a distribution drum that disperses the material, and a case surrounding a space between the distribution drum and the accumulator, and disperses the material in air inside the case, and an air flow adjustor configured to adjust an air flow in the second direction inside the case as controlled by the controller.

Another aspect of the invention is a web processing device including: a distributor configured to disperse material containing fiber; an accumulator configured to accumulate the material dispersed by the distributor and form a web; a conveyor configured to convey the web in a first direction; a first compression device configured to compress the web conveyed in the first direction; a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the first compression device, or after the web is compressed by the first compression device; a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web; and a second compression device configured to compress the web after measurement by the measurement device and compression by the first compression device.

In a web processing device according to another aspect of the invention, the first compression device compresses the web with less pressure than the second compression device.

To achieve the foregoing objective, another aspect of the invention is a fibrous feedstock recycling device including: a defibrator configured to defibrate feedstock containing fiber; a distributor configured to distribute defibrated material defibrated by the defibrator; an accumulator configured to accumulate the defibrated material distributed by the distributor, and form a web; a conveyor configured to convey the web in a first direction; a first compression device configured to compress the web conveyed in the first direction; a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the first compression device, or after the web is compressed by the first compression device; a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web; and a second compression device configured to compress the web after measurement by the measurement device and compression by the first compression device.

To achieve the foregoing objective, another aspect of the invention is a web forming method, including: distributing material containing fiber; accumulating the dispersed material and forming a web; conveying the web in a first direction; measuring a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed, or after the web is compressed; and comparing measurement results with a set thickness distribution, and control the thickness distribution of the web.

Other objects and attainments together with a fuller understanding of the invention will become apparent and appreciated by referring to the following description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically illustrates the configuration of a sheet manufacturing apparatus according to a first embodiment of the invention.

FIG. **2** is an oblique view of the distributor in the first embodiment of the invention.

FIG. **3** is a section view of the distributor in the first embodiment of the invention.

FIG. **4** schematically illustrates the configuration of the air current adjuster in the first embodiment of the invention.

FIG. **5** illustrates the configuration of another example of a distribution drum.

FIG. **6** is a perspective view of main parts of the distributor in the first embodiment of the invention.

FIG. **7** is a side view of main parts of the distributor in the first embodiment of the invention.

FIG. **8** is a graph showing an example of measurements taken by the optical detector in the first embodiment of the invention.

FIG. **9** is a function block diagram of a sheet manufacturing apparatus according to the first embodiment of the invention.

FIG. **10** is a flow chart of the operation of the sheet manufacturing apparatus according to the first embodiment of the invention.

FIG. **11** is a perspective view of the distributor in a second embodiment of the invention.

FIG. **12** is a section view illustrating the configuration of the air flow restrictor in the second embodiment of the invention.

FIG. **13** is a perspective view of the distributor in a third embodiment of the invention.

FIG. **14** is a function block diagram of a sheet manufacturing apparatus according to the third embodiment of the invention.

FIG. **15** is a perspective view of the distributor in a fourth embodiment of the invention.

FIG. **16** is a perspective view of the distributor in a fifth embodiment of the invention.

FIG. **17** is a function block diagram of a sheet manufacturing apparatus according to the fifth embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

Preferred embodiments of the invention are described below with reference to the accompanying figures. Note that the embodiments described below do not limit the content of the embodiment described in the accompanying claims. All configurations described below are also not necessarily essential elements of the invention.

1. Embodiment 1

1. General Configuration of a Sheet Manufacturing Apparatus

FIG. **1** schematically illustrates the configuration of a sheet manufacturing apparatus **100** according to the invention.

The sheet manufacturing apparatus **100** corresponds to a measuring device, a web processing device, and a fibrous feedstock recycling device according to the invention, and executes a recycling process of defibrating feedstock material MA containing fiber and making new sheets S from the fiber. The sheet manufacturing apparatus **100** can also mix additives with the feedstock material MA to adjust the binding strength (paper strength) or whiteness, or add color, scents, or functions such as fire retardancy to the sheet S.

The sheet manufacturing apparatus **100** can also adjust the density, thickness, size, and shape of the sheets S. Typical uses of the sheets S include office paper in standard sizes such as A4 or A3, various kinds of sheet products such as cleaning sheets for cleaning flooring, sheets for cleaning up oil and grease, and sheets cleaning toilets, as well as paper plates and other three dimensional forms, and other products such as cushioning materials, sound absorbent materials, and liquid absorbent materials.

The sheet manufacturing apparatus **100** includes a feedstock feeder **10**, shredder **12**, defibrator **20**, classifier **40**, first web former **45**, rotor **49**, mixing device **50**, distributor **60**, second web former **70**, conveyor **79**, former **80**, and sheet cutter **90**. The shredder **12**, defibrator **20**, classifier **40**, and first web former **45** configure a defibration processor **101** that defibrates the feedstock material MA and acquires material used to make the sheets S. The material produced by the defibration process unit **101** is referred to below as material MC.

The rotor **49**, mixing device **50**, distributor **60**, second web former **70**, former **80**, and sheet cutter **90** configure a sheet maker **102** that processes the material acquired by the defibration processor **101** and makes sheets S.

A configuration adding a rotor **49** and mixing device **50** to the defibration process unit **101** may also be referred to as a feedstock processing device. The feedstock processing device may be any configuration including at least the mixing device **50** that is capable of manufacturing a mixture MX from feedstock material MA containing fiber and the web material MC.

The feedstock feeder **10** in this example is an automatic sheet feeder that holds and continuously supplies the feedstock material MA to the shredder **12**. The feedstock material MA may be any material containing fiber, such as recovered paper, waste paper, and pulp sheets.

The shredder **12** has shredder blades **14**, shreds the feedstock material MA in air by the shredder blades **14**, and produces paper shreds a few centimeters square. The shape and size of the shreds is not specifically limited. A paper shredder, for example, may be used as the shredder **12**. The feedstock material MA shredded by the shredder **12** is then collected in a hopper **9**, and conveyed through a conduit **2** to the defibrator **20**.

The defibrator **20** defibrates the coarse shreds produced by the shredder **12**. Defibration is a process of breaking feedstock material MA containing bonded fibers into single fibers or a few intertwined fibers. The feedstock material MA may also be referred to as material to defibrate or defibration material. The material that has been defibrated by the defibrator **20** is referred to as defibrated material MB.

By the defibrator **20** defibrating the feedstock material MA, resin particles, ink, toner, bleeding inhibitors, and other materials included in the feedstock material MA can be expected to also separate from the fibers. In addition to defibrated fibers that have been separated, the defibrated material MB may contain additives that are separated from the fiber during defibration, including resin particles, ink, toner, and other color additives, bleeding inhibitors, and paper strengthening agents.

The defibrator **20** defibrates in a dry process. A dry process as used herein means that the defibration process is done in air or other gas instead of a wet solution. The defibrator **20** uses a defibrator such as an impeller mill in this example. More specifically, the defibrator **20** has a rotor (not shown in the figure), and a liner (not shown in the figure) positioned around the outside of the rotor, and the shreds go between the rotor and the liner and are defibrated.

The shreds are conveyed by an air current from the shredder **12** to the defibrator **20**. The defibrated material MB is carried by the air current from the defibrator **20** through a conduit **3** to the classifier **40**. The air current conveying the defibrated material may be generated by the defibrator **20** or the air current may be generated by a blower not shown.

The classifier **40** separates the components contained in the defibrated material MB by the size of the fiber. The size of the fiber primarily indicates the length of the fiber. The classifier **40** includes a drum **41**, and a housing **43** enclosing the drum **41**.

The drum **41** in this example is a sieve such as mesh, a filter or a screen with openings. More specifically, the drum **41** is a cylinder that is rotationally driven by a motor, and has mesh in at least part of its outside surface. The mesh of the drum **41** may be a metal screen, expanded metal made by expanding a metal sheet with slits formed therein, or punched metal, for example.

Defibrated material MB introduced from the inlet **42** to the inside of the drum **41** is separated by rotation of the drum **41** into precipitate that passes through the openings in the drum **41**, and remnants that do not pass through the openings.

The precipitate that passes through the openings contains fiber and particles smaller than the openings, and is referred to as first screened material.

The remnants include fibers, undefibrated shreds, and clumps that are larger than the openings, and are referred to as second screened material.

The first screened material precipitates inside the housing **43** and descends to the first web former **45**. The second screened material is conveyed through a conduit **8** to the defibrator **20** from an exit opening **44** that communicates with the inside of the drum **41**.

Instead of using a sieve-type classifier **40**, the sheet manufacturing apparatus **100** may use a cyclone classifier, elbow-jet classifier, or eddy classifier, for example, that selects and separates the first screened material and second screened material.

The first web former **45** includes a mesh belt **46**, tension rollers **47**, and a suction device **48**. The mesh belt **46** is an endless metal belt, and is mounted around multiple tension rollers **47**. The mesh belt **46** circulates in a path configured by the tension rollers **47**. Part of the path of the mesh belt **46** is flat in the area below the drum **41**, and the mesh belt **46** forms a flat surface.

Numerous openings are formed in the mesh belt **46**, and components of the first screened material that descends from the drum **41** and are larger than the openings in the mesh belt **46** accumulate on the mesh belt **46**. Components of the first screened material that are smaller than the openings in the mesh belt **46** pass through the openings.

Materials that pass through the openings in the mesh belt **46** are referred to as third screened material, and include, for example, resin particles, ink, toner, bleeding inhibitors, and other particles that are separated from the fiber by the defibrator **20**.

The suction device **48** pulls air from below the mesh belt **46**. The suction device **48** is connected through a conduit **23** to a first dust collector **27**. The first dust collector **27** separates the third screened material from the air current. Downstream from the first dust collector **27** is a first collection blower **28**, and the first collection blower **28** suctions air from the first dust collector **27** and discharges air through the conduit **29** to the outside of the sheet manufacturing apparatus **100**.

The third screened material that passes through the openings in the mesh belt **46** is captured by the first dust collector **27**. Because the first screened material descending from the drum **41** is pulled to the mesh belt **46** by the air current suctioned by the suction device **48**, the air current has the effect of promoting accumulation of the first screened material.

The material accumulated on the mesh belt **46** is formed into a web, and becomes a first web W**1**. More specifically, the first web former **45** forms a first web W**1** from the first screened material selected by the classifier **40**.

Of the components of the first screened material, the first web W**1** comprises mainly fibers that are larger than the openings in the mesh belt **46**, and is a fluffy web containing much air. The first web W**1** is conveyed by movement of the mesh belt **46** to the rotor **49**.

The rotor **49** has a base **49*a*** connected to a driver such as a motor not shown in the figure, and fins **49*b*** protruding from the base **49*a***, and when the base **49*a*** is driven, the fins **49*b***. The fins **49*b*** in this example are flat blades.

The rotor **49** is disposed at the end of the path of the mesh belt **46**, and contacts the first web W**1** conveyed by the mesh belt **46** at the place where the first web W**1** protrudes from the mesh belt **46**. The first web W**1** is therefore broken up by the fins **49*b*** striking the first web W**1**, and reduced to small clumps of fiber, which are then conveyed through the conduit **7** to the mixing device **50**.

The material separated from the first web W**1** by the rotor **49** is web material MC. The first screened material MC is the first screened material from which the third screened material was removed, and its main component is fiber.

The mixing device **50** mixes the web material MC with an additive. The mixing device **50** has an additive supplier **52** that supplies an additive, and a mixing blower **56**. The mixing device **50** may also have a conduit **54** through which the web material MC and additive are conveyed.

One or more additive cartridges **52*a*** storing additives are installed to the additive supplier **52**. The additive cartridges **52*a*** may be removably installed to the additive supplier **52**. The additive supplier **52** includes an additive extractor **52*b*** that extracts additive from the additive cartridges **52*a***, and an additive injector **52*c*** that injects the additive extracted by the additive extractor **52*b*** into the conduit **54**.

The additive extractor **52*b*** feeds additive in an additive cartridges **52*a*** to the additive applicator **52*c*** by means of a feeder not shown in the figure.

The additive injector **52*c*** has a shutter that opens and closes, and when the shutter is open, the additive extracted by the additive extractor **52*b*** is fed into the conduit **54**.

The additive includes resin for binding multiple fibers together. The resin contained in the additive functions as a binder, melts when passing through the sheet former **80**, for example, and binds together multiple fibers contained in the web material MC.

The additive supplied may also contain components other than resin for binding fibers. For example, the additive may also include a coloring agent, an anti-blocking agent to prevent agglomeration of fibers or agglomeration of resin, or a flame retardant for making the fiber difficult to burn. The additive may also be in the form of fibers or powder.

The mixing blower **56** produces an air current flowing through a conduit **54** connecting conduit **7** to the distributor **60**, and mixes the web material MC with the additive.

The mixing blower **56** in this example is configured with a motor, blades that turn as driven by the motor, and a case housing the blades. In addition to blades for producing an air current, the mixing blower **56** may also include a mixer for mixing the web material MC and the additive.

The mixture mixed by the mixing device **50** is referred to below as mixture MX. The mixture MX is an example of material containing fiber. The mixture MX is conveyed to the distributor **60** and introduced to the distributor **60** by the air current produced by the mixing blower **56**.

The distributor **60** detangles the fibers in the mixture MX, and the detangled fibers are dispersed in air while descending to the second web former **70**. If the additive supplied from the additive supply device **52** is fibrous, these additive fibers are also detangled by the distributor **60** and descend to the second web former **70**.

The distributor **60** includes a dispersing drum **61**, and a housing **63** that houses the dispersing drum **61**. The dispersing drum **61** is a cylindrical structure configured similarly to the drum **41** described above, for example, rotates as driven by a motor (not shown in the figure) similarly to the drum **41**, and functions as a sieve. The dispersing drum **61** has openings, and the mixture MX detangled by rotation of the dispersing drum **61** falls through the openings. As a result, the mixture MX descends from the drum **61** in the internal space **62** formed inside the housing **63**. The housing **63** is equivalent to a case in the accompanying claims.

The second web former **70** is located below the dispersing drum **61**. The second web former **70** in this example includes a mesh belt **72**, tension rollers **74**, and a suction mechanism **76**.

The mesh belt **72** is an endless metal belt similar to the mesh belt **46** described above, and is mounted around multiple tension rollers **74**. The mesh belt **72** circulates in a path configured by the tension rollers **74**, and moves in the conveyance direction indicated by the arrow F**1**. Part of the path of the mesh belt **72** is flat in the area below the dispersing drum **61**, and the mesh belt **72** forms a flat surface.

In the flat part of the path of the mesh belt **72**, the conveyance direction F**1** matches the conveyance direction F**2** of the second web W**2**. Many holes are also formed in the mesh belt **72**.

The conveyance direction F**1** is an example of the first direction in the accompanying claims. The second web former **70** functions as an accumulator, and the mesh belt **72** is an example of a conveyor in the accompanying claims.

Components of the mixture MX falling from the dispersing drum **61** located above the mesh belt **72** that are larger than the openings in the mesh belt **72** accumulate on the mesh belt **72**. Components of the mixture MX that are smaller than the openings in the mesh belt **72** pass through the holes.

The suction mechanism **76** suctions air from the opposite side of the mesh belt **72** as the dispersing drum **61**. Material that passes through the openings in the mesh belt **72** is pulled into the suction mechanism **76**. The air current suctioned by the suction mechanism **76** pulls the mixture MX falling from the dispersing drum **61** to the mesh belt **72**, and effectively promotes accumulation of the mixture.

The air current suctioned by the suction mechanism **76** creates a down flow in the path of the mixture MX descending from the dispersing drum **61**, and can be expected to have the effect of preventing precipitating fibers from becoming tangled. The mixture accumulated on the mesh belt **72** is laid in a web, forming a second web W**2**.

The mesh belt **72** functions as an accumulator and a conveyor, and the surface of the mesh belt **72** is equivalent to a conveyance surface. The second web W**2** is an example of a web according to the invention, and accumulated product.

A second collection blower **68** is connected to the suction mechanism **76** through a conduit **66** and a second dust collector **67**. The second collection blower **68** suctions air from the suction mechanism **76**. The second dust collector **67** is a filter. The air current the second collection blower **68** generates passes through the conduit **66** to the second dust collector **67**, and fiber and particles contained in the air current are trapped in the second dust collector **67**. The air current passing the second dust collector **67** then passes from the second collection blower **68** through a discharge conduit not shown, and is discharged from the sheet manufacturing apparatus **100**.

The distributor **60** also has a first seal roller **64** and a second seal roller **65**. An opening **637** through which the mesh belt **72** enters the internal space **62** is formed at the upstream end of the housing **63** in the conveyance direction F**1**.

Another opening **638** through which the mesh belt **72** and the second web W**2** are discharged from the internal space **62** is formed at the downstream end of the housing **63** in the conveyance direction F**1**. This opening **638** is an example of a discharge opening (exit).

The first seal roller **64** is a roller that contacts the mesh belt **72** at the opening **637**. The first seal roller **64** closes the gap formed around the mesh belt **72** at the upstream opening **637**.

The second seal roller **65** is a roller that contacts the second web W**2** on the mesh belt **72** at the opening **638**. The second seal roller **65** closes the gap around the mesh belt **72** and the second web W**2** at the downstream opening **638**.

The first seal roller **64** and second seal roller **65** do not completely close the openings **637**, **638**, but effectively suppress the flow of air through the openings **637**, **638**. More specifically, the first seal roller **64** and second seal roller **65** have the effect of limiting the air current flowing from the openings **637**, **638** to the suction mechanism **76**. As a result, the air current suctioned by the suction mechanism **76** can more effectively suction the mixture MX inside the internal space **62**.

A measurement device **400** for measuring the thickness of the second web W**2** is disposed to the distributor **60** on the downstream side in the conveyance direction F**1**.

The measurement device **400** has an optical detector **401** for measuring the thickness of the second web W**2** conveyed to the outside from the distributor **60**. The optical detector **401** of the measurement device **400** in this example may be configured with an optical rangefinder that measures distance using light, or a contact sensor that contacts the second web W**2**.

In this embodiment, the measurement device **400** uses as the optical detector **401** an optical rangefinder that measures distance by emitting a light beam and detecting the reflection. The optical detector **401** may be a laser rangefinder that emits a laser beam and detects the laser beam reflected from the target (second web W**2**), or an infrared rangefinder that emits an infrared beam and detects the infrared reflection.

The measurement device **400** measures the thickness of the second web W**2** by means of the optical detector **401**. The optical detector **401** connects to a controller **110** that controls operation of the sheet manufacturing apparatus **100**, executes measurements related to the second web W**2**, and outputs the result to the controller **110**. As a result, the controller **110** can measure the thickness of the second web W**2** and acquire the detected thickness continuously during the operation of manufacturing a sheet S.

A wetting device **78** is disposed to the conveyance path of the mesh belt **72** downstream from the distributor **60**. The wetting device **78** is a mist humidifier that produces and supplies a water mist to the mesh belt **72**, and in this example has a tank that holds water, and an ultrasonic vibrator that converts the water to mist. Because the moisture content of the second web W**2** can be adjusted by the mist supplied by the wetting device **78**, the mist can suppress accretion of fiber on the mesh belt **72** due to static electricity.

The second web W**2** is then conveyed by the conveyor **79**, separates from the mesh belt **72**, and is conveyed to the former **80**. The conveyance direction of the second web W**2** is conveyance direction F**2**. The conveyor **79** in this example has a mesh belt **79***a*, rollers **79***b*, and a suction mechanism **79***c*.

The suction mechanism **79***c* has a blower not shown, and produces an air current flowing upward through the mesh belt **79***a* by the suction of the blower.

The mesh belt **79***a* is configured by an endless metal belt with numerous openings in the same way as the mesh belt **46** and mesh belt **72**. The mesh belt **79***a* moves by rotation of the rollers **79***b* and moves along a circulating path. The second web W**2** is separated from the mesh belt **72** and pulled to the mesh belt **79***a* by the suction force of the suction mechanism **79***c* in the conveyor **79**. The second web W**2** moves with the mesh belt **79***a* and is conveyed to the former **80**.

The former **80** has a compression device **82** and a heating device **84**. The compression device **82** compresses the second web W**2** with a specific nip pressure, adjusts the thickness of the second web W**2**, and changes the density of the second web W**2**. By applying heat to the second web W**2**, the heating device **84** binds the fibers derived from the web material MC contained in the second web W**2** through the resin contained in the additive.

The compression device **82** comprises a pair of calender rolls **85**. The compression device **82** has a hydraulic press mechanism that applies nip pressure to the calender rolls **85**, and a motor that causes the calender rolls **85** to rotate.

The heating device **84** includes a pair of heat rollers **86**. The heating device **84** also has a heater (not shown in the figure) that heats the surface of the heat rollers **86** to a specific temperature, and a motor (not shown in the figure) that causes the heat rollers **86** to rotate in the direction of the sheet cutter **90**. The second web W**2** is heated in the heating device **84** to a temperature greater than the glass transition temperature of the resin contained in the mixture MX, forming a sheet S.

The sheet cutter **90** cuts the sheet S formed by the former **80**. In this example, the sheet cutter **90** has a first cutter **92** that cuts the sheet S crosswise to the conveyance direction of the sheet S indicated by the arrow F**2** in the figure, and a second cutter **94** that cuts the sheet S parallel to the conveyance direction F**2**.

The sheet cutter **90** cuts the length and width of the sheet S to a specific size, forming single sheets S. The single sheets S cut by the sheet cutter **90** are then stored in the discharge tray **96**. The discharge tray **96** may be a tray or stacker for holding the manufactured sheets, and the sheets S discharged to the tray can be removed and used by the user.

The defibration process unit **101** and sheet maker **102** of the sheet manufacturing apparatus **100** described in this example are configured as an integrated unit, but may be disposed separately. The web material MC and first web W**1** produced by the defibration process unit **101** may be removed from the sheet manufacturing apparatus **100** and stored, or it may also be sealed in specific packages in a form ready for shipping or sale. In this case, the sheet maker **102** may be configured to manufacture sheets S by processing the first web W**1** or web material MC that is stored or is sealed in packages.

The sheet manufacturing apparatus **100** configured as described above may have, in addition to the wetting device **78**, another humidifying device not shown that supplies humidified air. The humidifying device (humidifier) in this example is more specifically configured by a heaterless humidifier that supplies air with a high moisture content by passing air through a filter impregnated with water. For example, a configuration that supplies humidified air from a humidifier to the shredder **12**, defibrator **20**, classifier **40**, mixing device **50**, and distributor **60** may be used. By supplying humidified air to each of these components, moisture may be added to the shreds produced by the shredder **12**, the defibrated material MB defibrated by the defibrator **20**, the web material MC and the mixture MX supplied to the mixing device **50**. As a result, electrically charging the shreds, defibrated material MB, web material MC, and mixture MX can be suppressed, and accretion of powder and particles by the effects of static electricity to the inside of the components and the connecting conduits can be suppressed. Therefore, conveyance of the shreds, defibrated material MB, web material MC, and mixture MX through the sheet manufacturing apparatus **100** can be stabilized. Maintenance work to remove powder and particles accreted on parts of the sheet manufacturing apparatus **100** can also be reduced.

1-2. Distributor Configuration

FIG. **2** is a perspective view of the distributor **60**. FIG. **2** shows the conduit **54** connected to the distributor **60**, together with the mesh belt **72** and the controller **110**. FIG. **3** is a section view of the distributor **60**.

In FIG. **2** and below, the directions to above and below the sheet manufacturing apparatus **100** when in the operating position are referred to as the up direction U and down direction D.

The direction perpendicular to the conveyance direction F**1** of the second web W**2** formed in the distributor **60** and second web former **70** is the direction to left and right, referred to as respectively as the left L and right R.

The direction across the width of the second web W**2** is referred to as the width direction WD. The width direction WD is a direction intersecting the conveyance direction F**1**, and in this embodiment of the invention is the same as the left-right direction L-R.

The direction U and down direction D are perpendicular to the plane containing the width direction WD and the conveyance direction F**1**. The width direction WD is also referred to as a second direction.

As shown in FIG. **2** and FIG. **3**, the distribution drum **61** is a hollow tube disposed to rotate on an axis of rotation Q. Numerous holes **61***a* are formed in the outside surface **61***b* of the distribution drum **61**. As the distribution drum **61** turns, fiber passes through the holes **61***a*, descends, and accumulates on the mesh belt **72**, forming a second web W**2**. The size, shape, and number of holes **61***a* formed in the distribution drum **61** are not specifically limited. For convenience of illustration, the size of the holes **61**a relative to the distribution drum **61** is exaggerated in FIG. **2** and FIG. **3**.

The housing **63** has an opposing wall **636** with an inside surface opposite the outside surface **61**b, and a right wall **633** and opposing left wall **634**. The right wall **633** and left wall **634** are connected to the opposing wall **636**, and enclose the distribution drum **61** from opposite sides on the axis of rotation Q. In other words, the housing **63** forms a space between the right wall **633**, left wall **634**, and opposing wall **636**, and houses the distribution drum **61** in this space. A space is also formed between the housing **63** and the outside surface **61**b of the distribution drum **61** held inside the housing **63**.

As shown in FIG. **3**, a recess **69** is formed in the inside surfaces of the right wall **633** and left wall **634**. The axial ends of the distribution drum **61** are fit inside the recesses **69**, and a pile seal **69**a is provided to fill the gaps between the ends of the distribution drum **61** and the recesses **69**. The distribution drum **61** is supported rotationally to the housing **63** by the pile seal **69**a. The pile seal **69**a in this example is a brush with bristles of synthetic resin or natural hair.

A conduit **54** connects to the distributor **60**, and air carrying a mixture MX is supplied through the conduit **54**. As shown in FIG. **2**, the conduit **54** is configured with a single main conduit **54**a that connects to the mixing blower **56**, and branch conduits **54**c and **54**d that diverge from a common junction **54**b. One branch conduit **54**c connects to air line **57**a, and **54**d connects to air line **57**b.

The air current produced by the mixing blower **56** shown in FIG. **1** flows through the main conduit **54**a as conveyance current M1 carrying the mixture MX. The conveyance current M1 diverges at the junction **54**b into conveyance current M2 flowing through the branch conduit **54**c, and conveyance current M3 flowing through branch conduit **54**d. Conveyance current M2 and conveyance current M3 are air currents supplying the mixture MX to the distribution drum **61**. In this example, branch conduits **54**c and **54**d function as material suppliers.

Air lines **57**a and **57**b connect respectively to the right wall **633** and left wall **634** of the housing **63**. Air line **57**a passes through the right wall **633** and communicates with the inside of the distribution drum **61**. More specifically, the housing **63** has a supply port **633**a that opens into the space inside the distribution drum **61**. Likewise, air line **57**b passes through the left wall **634** and communicates with the inside of the distribution drum **61**. The housing **63** also has a supply port **634**a that opens into the space inside the distribution drum **61**.

Supply port **633**a is disposed to a position overlapping the axis of rotation Q as seen from the direction of the axis of rotation Q. Supply port **634**a is likewise disposed to a position overlapping the axis of rotation Q.

Conveyance current M2 passes from the branch conduit **54**c through the air line **57**a, and flows into the space inside the distribution drum **61** along the axis of rotation Q. Conveyance current M3 likewise passes from the branch conduit **54**d through the air line **57**b, and flows into the space inside the distribution drum **61** along the axis of rotation Q.

The mesh belt **72** is disposed below the housing **63**. The mesh belt **72** forms the bottom of the housing **63**, and continues to the outside of the housing **63** through the opening **63**a formed at the bottom of the housing **63**. The material that descends from the distribution drum **61** accumulates on the accumulation surface **72**a, which is the top surface of the mesh belt **72**.

A suction mechanism **76** is disposed below the mesh belt **72**, suctions air through the mesh belt **72** by the suction produced by the second collection blower **68**, and thereby produces suction current M4 passing through the mesh belt **72**.

As conveyance currents M2 and M3 flow into the distribution drum **61** in the space inside the housing **63**, the conveyance currents M2 and M3 are suctioned from below by the suction mechanism **76**. This produces a downward flow DR in the down direction D from inside the distribution drum **61**, and material is carried by the downward flow DR to the accumulation surface **72**a.

A pile seal **69**b is also disposed between the housing **63** and the mesh belt **72**. The pile seal **69**b in this example is a brush with bristles of synthetic resin or natural hair, and is disposed between the right wall **633** and mesh belt **72** and between the left wall **634** and mesh belt **72**. The pile seal **69**b suppresses leakage from the mixture MX from the gaps between the housing **63** and mesh belt **72**.

1-3. Configuration of the Air Current Adjustor

FIG. **4** schematically illustrates the configuration of the air current adjustor **801**. The air current adjustor **801** is a device disposed to the main conduit **54**a to adjust the ratio of the conveyance current M1 that flows as conveyance current M2 and conveyance current M3.

The air current adjustor **801** includes a rotatably disposed pivot shaft **803**, and a flap **805** affixed to the pivot shaft **803**. The air current adjustor **801** also has an actuator or motor not shown that causes the pivot shaft **803** to rotate as controlled by the controller **110**. The pivot shaft **803** turns in the direction of arrow RT2 in the figure as driven by the actuator or motor not shown, causing the position of the flap **805** to change.

By adjusting the position of the flap **805**, the controller **110** can adjust the ratio between the conveyance current M2 and conveyance current M3 at the junction **54**b. More specifically, when the position of the flap **805** is biased to the branch conduit **54**c side, the flow of conveyance current M2 is greater than conveyance current M3. Likewise, when the position of the flap **805** is biased to the branch conduit **54**d side, the flow of conveyance current M3 is greater than conveyance current M2. The controller **110** can therefore control the distribution of the conveyance current M1 to conveyance current M2 and conveyance current M3 by adjusting the position of the air current adjustor **801**.

The air current adjustor **801** in this configuration functions as an adjustor that adjusts the amount of mixture MX as the material supplied by the branch conduits **54**c and **54**d.

1-4. Configuration of the Distribution Drum

The distribution drum **61** shown in FIG. **2** and FIG. **4** is a cylindrical configuration with holes **61**a. The distribution drum **61** turns in direction of rotation RT1 by the drive power of a motor not shown as controlled by the controller **110**, and causes the mixture MX supplied into the distribution drum **61** to fall through the holes **61**a.

The configuration of the distribution drum **61** is not limited to a configuration in which the distribution drum **61** itself turns.

FIG. **5** is a perspective view of a distribution drum **610** with a different configuration than distribution drum **61**.

The distribution drum **610** has a drum **611**, which is a hollow cylindrical construction. The drum **611** has an internal space, and unlike the distribution drum **61** described above does not rotate. At least part of the circumferential surface of the drum **611** including the side on the down direction D is mesh **612** with screen-like openings. The openings in the mesh **612** are sized to enable resin and other particles contained in the mixture MX to pass through. In this example, the mesh **612** is a metal screen.

A rotational shaft **613** is disposed in the hollow inside **615**. The rotational shaft **613** is connected to a motor not shown that operates as controlled by the controller **110**, and is supported rotationally to the drum **611**. The rotational shaft **613** can turn clockwise and counterclockwise as driven by the motor as indicated by the arrow RT**3** in the figure. The rotational shaft **613** may be configured to reverse the direction of rotation. More specifically, the motor that drives the rotational shaft **613** may be configured to change the direction of rotation between a forward direction and a reverse direction as controlled by the controller **110**.

A flap **614** is affixed to the rotational shaft **613**. The flap **614** is a blade that rotates in conjunction with the rotational shaft **613**. The shape and size of the flap **614** are not specifically limited as long as the flap **614** can rotate in the inside **615**.

When distribution drum **610** is used in the distributor **60** instead of distribution drum **61**, the mixture MX flows from the air lines **57***a* and **57***b* into the inside **615**. When the rotational shaft **613** then turns or rotates as controlled by the controller **110**, the mixture MX is stirred in the inside **615**, and the mixture MX falls in the down direction D through the mesh **612**. As a result, the mixture MX descends to and accumulates on the mesh belt **72**.

Similarly to the distribution drum **61** described above, the distribution drum **610** temporarily holds the mixture MX supplied from the conduit **54**, and then disperses and causes the mixture MX to precipitate to the mesh belt **72**. Because the distribution drum **610** also stirs (mixes) the mixture MX by means of the flap **614**, the distribution drum **610** also breaks up any clumps of fiber or resin that may be in the mixture MX, thereby forming a second web W**2** of good quality. This effect is the same as the effect of the distribution drum **61** described above.

The distributor **60** may be configured using either distribution drum **61** or distribution drum **610**. The configuration of the distributor **60** is also not specifically limited, and the distributor **60** may obviously be configured with a distribution drum configured differently from distribution drums **61** and **610**, but this embodiment of the invention is described using distribution drum **61** by way of example.

1-5. Configuration of the Roller Unit

As shown in FIG. **2**, a roller unit **650** is disposed to the distributor **60**. The roller unit **650** has a second seal roller **65** and a construction that supports the second seal roller **65**.

FIG. **6** is a perspective view of the main parts of the distributor **60**, and FIG. **7** is a side view of main parts of the distributor **60**.

The roller unit **650** has a roller frame **660** that supports the second seal roller **65**. As shown in FIG. **1**, the second seal roller **65** closes the opening **638** on the downstream side of the distribution drum **61** in the conveyance direction F**1**.

As described above, the second seal roller **65** is disposed outside the housing **63** to close the opening **638** formed at the bottom of the housing **63**.

The surface of the second seal roller **65** is configured by synthetic resin, and is preferably configured with an elastomer or other elastic material.

The second cleaner **656** is a synthetic resin or rubber blade that contacts the surface of the second seal roller **65**, and with the blade wipes off fiber and particles sticking to the second seal roller **65**.

The support structure that supports the second seal roller **65** includes a roller frame **660**, subframe **663**, and coil spring **665**.

The subframe **663** is a frame affixed to the front panel **61***c* forming the front of the distribution drum **61**. The subframe **663** is disposed at the bottom of the distribution drum **61**, and extends along the width direction WD. The subframe **663** extends to the downstream side of the distribution drum **61** in the conveyance direction F**1**, and supports various members.

The roller frame **660** is an open frame that supports the roller shaft **651**, which is the rotational axis of the second seal roller **65**.

A gear **652** is fit onto the end of the roller shaft **651**, and as shown in FIG. **7** the gear **652** is held on the roller shaft **651** by a retaining ring **654**.

The gear **652** is connected to a motor or drive gear not shown, and the roller shaft **651** turns according to the torque transferred to the gear **652**.

By driving the gear **652**, the second seal roller **65** turns at a rotational speed corresponding to the movement of the mesh belt **72** in the conveyance direction F**1**. More specifically, the speed of the second web W**2** in the conveyance direction F**1**, and the speed of the surface of the second seal roller **65**, are controlled by the controller **110** to substantially the same speed. As a result, even if the second seal roller **65** contacts the second web W**2**, the surface of the second web W**2** is not disrupted, and the second web W**2** can be conveyed consistently because the second seal roller **65** does not interfere with conveyance of the second web W**2**.

A bearing block **653** supporting the roller shaft **651** is affixed to the end of the roller frame **660**. The bearing block **653** is a bearing that supports the roller shaft **651** freely rotatably, and in this example supports the roller shaft **651** by a bearing not shown in the figure.

The bearing block **653** is connected to the subframe **663** through a coil spring **665**. The coil spring **665** is a compression spring, expands between the subframe **663** and the bearing block **653**, and applies urging force to the subframe **663** and bearing block **653**. Because the subframe **663** is fastened to the frame members **631**, the urging force of the coil spring **665** works in the down direction D. As a result, the coil spring **665** pushes the bearing block **653** and the second seal roller **65** toward the second web W**2**.

The roller frame **660** is supported on the subframe **663** through the second seal roller **65** and the coil spring **665**. As a result, the roller frame **660** can move with the second seal roller **65** in the extension range of the coil spring **665**.

FIG. **7** shows the configuration at one end of the roller unit **650** in the width direction WD, but the same configuration is also disposed at the other end of the roller unit **650**. More specifically, both ends of the second seal roller **65** are supported by a bearing block **653**, and each of the two bearing blocks **653** is connected through a coil spring **665** to the subframe **663**.

Therefore, the second seal roller **65** and the roller frame **660** that supports the second seal roller **65** are respectively supported through coil springs **665** at both ends of the second seal roller **65** in the width direction WD.

Note that the roller shaft **651** may be disposed to only one of the ends of the second seal roller **65**.

The second seal roller **65** contacts the second web W**2** from above. The weight of the second seal roller **65** and roller frame **660**, and the urging force of the coil spring **665**, both work as pressure in the down direction D. In this event, the second seal roller **65** works as a pressure roller. The roller unit **650** therefore functions as a compressor and a first compressor.

Inside the internal space **62** of the housing **63** there is a large amount of air between the fibers contained in the second web W**2**, the fibers are randomly oriented, and the second web W**2** is generally soft and fluffy. There are also numerous peaks and valleys in the top surface of the second web W**2**.

The second web W**2** is compressed to a high density by the second seal roller **65** as it passes through the opening **638**. The smoothness of the surface of the second web W**2** is also increased by the peaks and valleys in the surface being compressed.

The pressure the second seal roller **65** applies to the second web W**2** is less than the pressure the compression device **82** shown in FIG. **1** applies to the second web W**2**. The compression device **82** compresses the second web W**2** to a high density to make a sheet S. If the sheets S are processed into plain paper with grammage of 60 g/m^2 to 80 g/m^2, the thickness ranges from approximately 0.08 mm to 0.14 mm. The thickness to which the second web W**2** is compressed by the sheet former **80** is equivalent to the thickness of the sheets S.

Note that the compression device **82** is an example of a second compression device.

Because the pressure the second seal roller **65** applies to compress the second web W**2** is lower than the pressure applied by the sheet former **80**, the thickness of the second web W**2** after passing through the second seal roller **65** is greater than the thickness of the sheets S. This thickness is measured by the optical detector **401**.

1-6. Configuration of the Measurement Device

The construction and operation of a configuration for measuring the thickness of the second web W**2** by means of the measurement device **400** is described below.

As shown in FIG. **7**, each of the optical detectors **401** of the measurement device **400** is affixed by an attachment fixture **405**. The attachment fixture **405** is a bracket that connects the subframe **663** and the optical detectors **401**, and the optical detector **401** is attached by this configuration to the distribution drum **61**.

In this embodiment of the invention three optical detectors **401** are attached to the subframe **663** by respective attachment fixtures **405**. Each of the three optical detectors **401** measures the distance to the second web W**2**, and outputs the measurement to the controller **110**. More specifically, because the thickness of the second web W**2** is measured at different positions along the width direction WD, the controller **110** can calculate the distribution of the thickness of the second web W**2** along the width direction WD based on the measurements.

The light beam the optical detector **401** uses to measure distance is indicated by dotted line DL in FIG. **7**. This measurement beam DL is emitted from the optical detector **401** directly to the surface of the second web W**2**. As a result, the optical detector **401** in this embodiment of the invention measures the distance TH from the optical detector **401** to the second web W**2**.

The position PP**2** where the optical detector **401** measures the distance TH is downstream in the conveyance direction F**1** from the position PP**1** where the second seal roller **65** compresses the second web W**2**. More specifically, the optical detector **401** measures the distance to the second web W**2** after compression by the second seal roller **65**.

As a result, the optical detector **401** can measure the thickness after the second web W**2** is compressed to a suitably high density and roughness (peaks and valleys) in the surface of the second web W**2** is smoothened by the second seal roller **65**. That is, the thickness of the second web W**2** can be reliably measured with high accuracy because the measurement is taken after the second web W**2** is processed to a state enabling consistent measurement.

The measurement taken by the optical detector **401** is the distance TH shown in FIG. **7**. This distance TH is not a value directly expressing the thickness of the second web W**2**. If the measurement the optical detector **401** takes when a second web W**2** is not on the mesh belt **72** is reference distance THD, the thickness DW**2** of the second web W**2** is calculated by equation (1) below from the distance TH measured by the optical detector **401**. The reference distance THD is the distance from the optical detector **401** to the surface of the mesh belt **72**, that is, the accumulation surface on which the second web W**2** is accumulated.

$$DW2=THD-TH \quad (1)$$

The controller **110** may compute equation (1) above. Alternatively, when the optical detector **401** is configured with an arithmetic processor for calculating the distance measurement acquired with the measurement beam DL, the optical detector **401** may compute equation (1).

In this embodiment of the invention the controller **110** computes equation (1). To execute this calculation process, the controller **110** stores data indicating the reference distance THD. The reference distance THD may differ according to the position of the optical detector **401** on the width direction WD. As a result, the controller **110** preferably stores a reference distance THD specific to each of the three optical detectors **401**, and calculates equation (1) using the measurement from each optical detector **401** and the reference distance THD corresponding to each optical detector **401**.

FIG. **8** is a graph shows examples of measurements taken by the optical detector **401**, the Y-axis showing the measurement of the thickness of the second web W**2**, and the X-axis showing the passage of time.

In FIG. **8** (*a*) represents the measurement taken by the optical detector **401**. The measurements of (a) in FIG. **8** are the measurements taken by one of the three optical detectors **401** of the sheet manufacturing apparatus **100**. More specifically, the measurements indicated by (a) in FIG. **8** are the measurements of the thickness of the second web W**2** taken after compression by the second seal roller **65**.

For comparison, (b) indicates examples of the thickness of the second web W**2** measured without compression by the second seal roller **65**. These measurements (b) are the measurements of the thickness of the second web W**2** taken by the optical detector **401** when the second web W**2** has not been compressed by the second seal roller **65**. More specifically, these are the measurements made by the optical detector **401** when the second web W**2** is produced without the second seal roller **65** installed to the sheet manufacturing apparatus **100**. Note that measurements (a) and measurements (b) are shown in FIG. **8** using the same scale.

The origin of the time axis in FIG. **8** is when the sheet manufacturing apparatus **100** starts manufacturing a sheet S. In the example in FIG. **8**, the time axes of measurements (a) and (b) are aligned for ease of comparison. More specifically, time t1 of measurements (a) and (b) is when the second web W2 reaches the point directly below the optical detector **401**.

At time t1 measurements (a) and (b) change greatly. This is because directly after second web W2 production starts, the amount of fiber that accumulates on the mesh belt **46** easily changes. These measurements (a) and (b) then stabilize at time t**2**.

Comparing measurements (a) and (b) after time t**2**, measurement (a) is less than measurement (b). This is because the second web W2 has been compressed by the second seal roller **65**.

From time t**2**, both measurements (a) and (b) remain generally constant. More specifically, measurements (a) and (b) vary, but the variation in the measurements is contained within a specific range. Comparing the range (width) of variation, the variation in measurement (b) is great enough to confirm a clear variation. On the other hand, measurement (a) varies as does measurement (b), but the range (width) of variation is less than in measurement (b).

The change in measurements (a) and (b) is due to the peaks and valleys (roughness) in the surface of the second web W2. The optical detector **401** measures distance based on the reflection of the measurement beam DL, and the measurement changes according to whether the position to which the measurement beam DL is emitted is a valley, a peak, or a point in between. Measurement (b) is the measurement of the second web W2 when fiber has accumulated on the mesh belt **72** and is soft and fluffy. Because the difference between the peaks and valleys in the surface of the uncompressed second web W2 is great, measurement (b) also varies greatly.

When the second seal roller **65** compresses the second web W**2**, the density of the second web W**2** at the measurement position PP**2** of the optical detector **401** increases, and the peaks and valleys of the fiber become smaller. Variation in measurement (a) is therefore significantly less than in measurement (b).

If change in the measurement is great, achieving great accuracy in the measurement is difficult. For example, if the thickness of the second web W2 is monitored based on measurement (b), the thickness of the second web W2 cannot be determined to be abnormal if the thickness is within the range of variation after time t2, and abnormal detection precision does not go below the allowable range of variation. As a result, even if something that affects the thickness of the second web W2 happens, occurrence of an abnormality cannot be detected until a change in thickness exceeding the allowable range of change occurs after time t**2**. The detection precision of abnormal thickness when the thickness of the second web W2 is monitored based on the measurement (a) is therefore set according the range of variation in measurement (a), and is more precise than using measurement (b).

A configuration capable of acquiring measurements with little variation such as with measurement (a) can therefore quickly detect change in the thickness of the second web W2 based on the measurements from the optical detectors **401**, and has the advantage of enabling managing the thickness of the second web W2 with great accuracy.

1-7. Control System of the Sheet Manufacturing Apparatus

FIG. **9** is a block diagram illustrating the configuration of the control system of the sheet manufacturing apparatus **100**.

The sheet manufacturing apparatus **100** includes a controller **110** having a processor **120** that controls parts of the sheet manufacturing apparatus **100**.

The controller **110** includes a processor **120** and memory **130**. The processor **120** controls parts of the controller **110** by executing a control program **131** stored in memory **130**.

The memory **130** is a storage device that nonvolatilely stores programs executed by the processor **120**, and data processed by the processor **120**, and in this example is a semiconductor memory device. The memory **130** may also include volatile memory for temporarily storing data and programs.

An operating panel **141** for inputting to the sheet manufacturing apparatus **100**, and an interface **142**, are connected to the controller **110**. The operating panel **141** is a touch panel configured integrally with a display panel, for example, and is disposed outside the sheet manufacturing apparatus **100**. The controller **110** detects operation of the operating panel **141**. The interface **142** is connected to an external device either by wire or wirelessly, and handles communication with external devices. Examples of such external devices include computer and storage devices that store data.

A conveyor **150** for operating the mesh belt **72**, a drum driver **152** that drives the distribution drum **61**, an air flow adjustor **154** that drives the air current adjustor **801**, and the optical detector **401** are connected to the controller **110**.

The conveyor **150** includes a motor (not shown in the figure) and one or more gears (not shown in the figure) for moving the mesh belt **72** in the conveyance direction F**1**.

Other motors and sensors that are part of the sheet manufacturing apparatus **100** are also connected to the controller **110**, but these configurations are not shown in FIG. **9**.

The processor **120** includes a drive controller **121** and measurement controller **122**. These components are embodied by the cooperation of hardware and software, or more specifically by the processor **120** executing the control program **131** in this example.

The drive controller **121** causes parts of the sheet manufacturing apparatus **100**, including the conveyor **150**, to operate.

The measurement controller **122** acquires the measurements acquired by the multiple optical detectors **401**. The measurement controller **122** then analyzes the measurements from the optical detectors **401**, and detects the thickness of the second web W2 in the conveyance direction F**1**, and variation in the thickness of the second web W2 along the width direction WD.

The memory **130** stores a control program **131** executed by the processor **120**. The memory **130** also stores drive parameters **132**, a thickness setting **133**, and measurement data **134**.

The drive parameters **132** includes parameters enabling the drive controller **121** to control driving parts of the sheet manufacturing apparatus **100**. The drive parameters **132** may include, for example, parameters related to the drive speed of the mesh belt **72** for the conveyor **150** to drive the mesh belt **72**, and the rotational speed that the air flow adjustor **154** drives the distribution drum **61**. The drive parameters **132** may also include parameters for the air flow adjustor **154** to drive the pivot shaft **803**.

The thickness setting **133** includes the second web W2 thickness setting. More specifically, the thickness setting **133** includes information relates to the thickness of the second web W2 required from the perspective of maintaining the quality of the sheet S, or information defining an allowable range of thickness in the second web W2. The thickness setting 133 is used by the processor 120 to determine whether or not the measurements from the optical detector 401 are appropriate or not.

The measurement data 134 is data including the measurements the measurement controller 122 acquired from the optical detectors 401. The measurement data 134 also includes data enabling the measurement controller 122 to calculate the thickness DW2 of the second web W2 from the measurements by the optical detectors 401. More specifically, the measurement data 134 includes data indicating the reference distance THD corresponding to each of the three optical detectors 401 in the measurement device 400. The reference distances THD are the measurements the optical detectors 401 acquire when the sheet manufacturing apparatus 100 is not manufacturing a sheet S.

The measurement data 134 may also include data indicating the measurements the measurement controller 122 acquired from the optical detectors 401.

The measurement data 134 may also include data about the thickness of the second web W2 the measurement controller 122 calculated based on the measurements acquired from the optical detectors 401. For example, the measurement controller 122 may calculate the thickness of the second web W2 each time a measurement is acquired from a optical detector 401, and store the calculated thickness as measurement data 134 in the memory 130. In this event, the measurement controller 122 can execute a process to detect the change in the thickness in the conveyance direction F1, and detect deviation in the thickness in the width direction WD, based on the thickness values included in the measurement data 134.

The measurement data 134 may also include multiple measurements taken at different times of measurement, that is, measurement times, or multiple second web W2 thickness values. As a result, the measurement controller 122 can detect change over time in the thickness. This changeover time in thickness indicates change in the thickness of the second web W2 in the conveyance direction F1.

FIG. 10 is a flow chart of the operation of the sheet manufacturing apparatus 100.

When the power of the sheet manufacturing apparatus 100 turns on (step ST1), the drive controller 121 of the controller 110 configures the operation settings of the sheet manufacturing apparatus 100 (step ST2). The settings of sheet manufacturing apparatus 100 operation are displayed in a configuration screen on the operating panel 141, and are set by the user inputting to the configuration screen. In step ST2, the number and type of sheets S for the sheet manufacturing apparatus 100 to manufacture, for example, are input by operating the operating panel 141, and the operation of the sheet manufacturing apparatus 100 is set based on the input content.

Based on the thickness setting 133 stored in the memory 130, the measurement controller 122 acquires a setting related to measuring the thickness of the second web W2 (step ST3). In this embodiment of the invention, the thickness setting 133 defines the range of acceptable measurements. More specifically, the thickness setting 133 includes information specifying a range of values determined acceptable for the thickness of the second web W2 obtained from the measurements taken by the optical detector 401.

The drive controller 121 the executes a startup sequence of initializing parts of the sheet manufacturing apparatus 100 (step ST4). The startup sequence sets the sheet manufacturing apparatus 100 to a condition enabling manufacturing sheets S. The startup sequence includes the drive controller 121 starting, in an appropriate order, the motors and blowers of the sheet manufacturing apparatus 100. After the startup sequence executes, the drive controller 121 starts manufacturing sheets S (step ST5).

After sheet S manufacturing starts, the measurement controller 122 acquires the measurements from the optical detectors 401, and calculates the thickness of the second web W2 from the acquired measurements (step ST6). In step ST6, the measurement controller 122 acquires the measurements from each of the multiple optical detectors 401 in the measurement device 400, and calculates the thickness of the second web W2 based on the measurements from each of the optical detectors 401. The measurement controller 122 also stores in the memory 130 as the measurement data 134 the measurements acquired in step ST6 and/or the calculated thickness of the second web W2.

The measurement controller 122 then determines whether or not the thickness calculated in step ST6 is a value within the setting range of the setting acquired in step ST3 (step ST7). The measurement controller 122 may make this decision by, for example, obtaining the average or median of the thickness of the second web W2 calculated based on the measurements of the multiple optical detectors 401, and determining whether or not the acquired value is within the set range.

Alternatively, the measurement controller 122 may decide based on whether or not each of the thicknesses of the second web W2 calculated based on the measurements of the multiple optical detectors 401 are within the setting range. In this event, the measurement controller 122 makes the decision in step ST7 based on whether or not the thickness of the second web W2 calculated from any one of the measurements is not a thickness within the set range.

If the measurement controller 122 determines the measured thickness is not within the range of settings (step ST7: NO), the drive controller 121 reports that the thickness is outside the allowable range by displaying a message, for example, on the screen of the operating panel 141 (step ST8). Next, the drive controller 121 changes the drive parameters of the drum driver 152 (step ST9), and adjusts the operation of the drum driver 152 based on the updated parameters (step ST10).

In step ST9, the drive parameters are changed so that the thickness of the second web W2 goes to a value within the set thickness range. For example, if the thickness of the second web W2 calculated from the measurements is thinner than the set thickness range, the drive controller 121 changes the drive parameters to increase the speed that the drum driver 152 rotationally drives the distribution drum 61. Conversely, if the thickness of the second web W2 calculated from the measurements is thicker than the set thickness range, for example, the drive controller 121 changes the drive parameters to decrease the speed that the drum driver 152 rotationally drives the distribution drum 61.

After the drive controller 121 adjusts operation of the drum driver 152 in step ST10, the controller 110 returns to step ST6.

If the measurement controller 122 determines the measured thickness is not within the range of settings (step ST7: YES), the measurement controller 122 detects the distribution of the thickness of the second web W2 along the width direction WD (step ST11).

The measurement controller 122 then determines whether or not the distribution of the thickness of the second web W2 is within the set range acquired in step ST3 (step ST12).

In step ST12 the measurement controller 122 determines, for example, whether or not the difference between the maximum and minimum thickness of the second web W**2** in the width direction WD is within the set range. Alternatively, the measurement controller **122** may statistically process the thickness of the second web W**2** acquired from each of the multiple measurements taken at the same time, and determine whether or not the acquired result is within the set range. For example, the measurement controller **122** may acquire the distribution or standard deviation of the thickness in the width direction WD.

If the measurement controller **122** determines the distribution of the thickness is not within the set range (step ST**12**: NO), the drive controller **121** reports that the distribution of thickness is outside the allowable range by displaying a message, for example, on the screen of the operating panel **141** (step ST**13**).

Next, the drive controller **121** changes the drive parameters of the air flow adjustor **154** (step ST**14**), and adjusts the operation of the air flow adjustor **154** based on the updated parameters (step ST**15**).

In step ST**14** the drive parameters are changed so that the distribution of the thickness of the second web W**2** goes to a value within the set thickness range. More specifically, the drive controller **121** changes the drive parameters to adjust the position of the flap **805** in the air current adjustor **801**. In this example this drive parameter is a parameter that specifies the angle of the pivot shaft **803**. This changes the ratio between the conveyance current M**2** and conveyance current M**3** flowing to the distribution drum **61**, and thereby changes the distribution of the accumulation of mixture MX on the width direction WD. As a result, the distribution of the thickness of the second web W**2** in the width direction WD is changed. After the measurement controller **122** adjusts the air flow adjustor **154** in step ST**15**, the controller **110** returns to step ST**6**.

If the measurement controller **122** determines the distribution of the thickness is within the set range (step ST**12**: YES), the drive controller **121** determines whether or not to stop operation of the sheet manufacturing apparatus **100** (step ST**16**). For example, if production of the number of sheets S set in step ST**2** is completed, or if operation is stopped by an operation of the operating panel **141**, the drive controller **121** determines to stop operation of the sheet manufacturing apparatus **100** (step ST**16**: YES).

In this event, the drive controller **121** executes a specific shutdown sequence (step ST**17**), and ends the process.

However, if the drive controller **121** determines to not stop operation of the sheet manufacturing apparatus **100** (step ST**16**: NO), the drive controller **121** returns to step ST**6**.

As described above, a sheet manufacturing apparatus **100** according to the first embodiment of the invention has a distributor **60** that distributes mixture MX as a mixture with material containing fiber, and a second web former **70** that forms a web by accumulating the mixture MX distributed by the distributor **60**.

A mesh belt **72** functions as a conveyor that conveys the second web W**2** accumulated by the second web former **70** in a conveyance direction F**1**.

The sheet manufacturing apparatus **100** also has a roller unit **650** that compresses the second web W**2** conveyed in the conveyance direction F**1**.

The sheet manufacturing apparatus **100** also has a measurement device **400** configured to measure the distribution of the thickness of the second web W**2** in a width direction WD, which intersects the conveyance direction F**1**, either while the second web W**2** is being compressed by the roller unit **650**, or after the second web W**2** is compressed by the roller unit **650**.

The sheet manufacturing apparatus **100** also has a controller **110**. The controller **110** compares the measurements acquired by the measurement device **400** with a predefined thickness distribution, and controls the thickness distribution of the second web W**2**.

A sheet manufacturing apparatus **100** using the web forming device, web processing device, and web forming method according to the invention can, by compressing the second web W**2**, measure the thickness distribution of the second web W**2** under appropriate conditions. The sheet manufacturing apparatus **100** compresses the second web W**2** by the roller unit **650**, and measures the thickness of the compressed second web W**2** by the measurement device **400**. As a result, the thickness can be measured after suppressing the effects of peaks and valleys due to fiber contained in the second web W**2**, and bulkiness in the second web W**2**. As a result, the thickness of the second web W**2** can be measured with great accuracy. In addition, based on the measurements, the distribution of the thickness of the second web W**2** in a width direction WD intersecting the conveyance direction F**1** of the second web W**2** can be detected with great accuracy. Therefore, by controlling the air flow adjustor **154** based on the thickness distribution of the second web W**2**, the thickness of the second web W**2** can be desirably maintained or adjusted.

A sheet manufacturing apparatus **100** using the fibrous feedstock recycling device of the invention has a defibrator **20** that defibrates feedstock containing fiber, and uses the distributor **60** to distribute a mixture MX acquired from the defibrated material defibrated by the defibrator **20**. The sheet manufacturing apparatus **100** also accumulates the mixture MX distributed by the distributor **60** and forms a second web W**2** by the second web former **70**, and conveys the second web W**2** accumulated by the second web former **70** in the conveyance direction F**1** by the mesh belt **72**.

The sheet manufacturing apparatus **100** also compresses the second web W**2** by the roller unit **650**, and after the second web W**2** is compressed by the roller unit **650**, measures the thickness of the second web W**2** by the measurement device **400**. The measurement device **400** measures the distribution of the thickness of the second web W**2** in a width direction WD intersecting the conveyance direction F**1**.

The sheet manufacturing apparatus **100** also has a controller **110** that compares the measurements acquired with a predefined thickness distribution, and controls the thickness distribution of the second web W**2**.

The sheet manufacturing apparatus **100** also functions as a fibrous feedstock recycling device that generates defibrated material MB from feedstock material MA, produces a mixture MX from the defibrated material MB, and makes sheets S from the mixture MX. In this configuration the sheet manufacturing apparatus **100** measures the thickness of the second web W**2** under conditions conducive to accurate measurement, and by controlling the thickness distribution of the second web W**2**, desirably maintains or adjusts the thickness of the second web W**2**.

The quality of the sheets S manufactured by the sheet manufacturing apparatus **100** can therefore be desirably maintained. Because the air flow adjustor **154** can be quickly adjusted when the thickness distribution in the width direction WD is not within the set thickness range, the volume of sheets S produced that do not satisfy the required conditions can be suppressed. As a result, productivity can be improved by improving yield.

In the first embodiment described above the measurement device **400** is configured to measure by the optical detector **401** at a position PP2 downstream from the position PP**1** where the second seal roller **65** compresses the second web W**2**. In this configuration the measurement device **400** measures the thickness of the second web W2 after compression by the roller unit **650**, but the invention is not so limited.

For example, the measurement device **400** may be configured so that the optical detector **401** measures the displacement of the second seal roller **65**. More specifically, the optical detector **401** may be configured to measure the position of the roller frame **660** that displaces in conjunction with the second seal roller **65** due to the elasticity of a coil spring **665**. This configuration also enables the measurement device **400** to measure the second web W2 as it is being compressed by the roller unit **650**.

The measurement device **400** of the sheet manufacturing apparatus **100** has multiple optical detectors **401** disposed along the width direction WD. The thickness distribution of the second web W2 can be accurately measured along the width direction WD based on the measurements from each of the optical detectors **401**.

The sheet manufacturing apparatus **100** also has air lines **57***a* and **57***b* that carry the mixture MX to the distributor **60**. The sheet manufacturing apparatus **100** also has an air current adjustor **801** and an air flow adjustor **154** that adjust the amount of mixture MX supplied to the distributor **60** by the air lines **57***a* and **57***b* as controlled by the controller **110**. As a result, the controller **110** can control adjusting the distribution of mixture MX in the width direction WD inside the distribution drum **61** according to the distribution of the thickness of the second web W2 acquired from the measurements by the measurement device **400**. As a result, the distribution of the thickness of the second web W2 can be desirably adjusted.

The distributor **60** has a housing **63**. The housing **63** is a case enclosing the distribution drum **61**, and the mesh belt **72** used as the accumulator of the second web former **70**. The distributor **60** also has a distribution drum **61** that distributes the mixture MX in air inside the housing **63**.

The sheet manufacturing apparatus **100** also has an air current adjustor **801** that adjusts the air flow in the width direction WD inside the housing **63** as controlled by the controller **110**. This configuration enables adjusting the distribution of mixture MX in the width direction WD inside the distribution drum **61** as controlled by the controller **110**, and thereby adjusting the distribution of the thickness of the second web W2. For example, the air current adjustor **801** can adjust the balance of the air flow in the width direction WD.

The sheet manufacturing apparatus **100** also has a compression device **82**, and the roller unit **650** compresses the second web W2 with less pressure than applied by the compression device **82**. This configuration enables measuring the thickness of the second web W2 of accumulated fiber after the second web W2 is compressed to a stable condition and before the second web W2 is compressed by the compression device **82**.

In addition, because the thickness of the second web W2 is measured in the distributor **60** in a process before compression by the compression device **82**, change in the amount of mixture MX accumulated on the mesh belt **72** in the distributor **60** can be quickly detected. As a result, the operating conditions of the distributor **60** can be controlled by the controller **110** to adjust only the thickness of the second web W**2**, operation can be quickly adjusted according to change in the thickness of the second web W**2**, and consistent quality in the sheet S can be promoted.

Furthermore, because the roller unit **650** compresses the web with lower pressure than applied by the compression device **82**, the second web W2 can be compressed sufficiently to smoothen and level roughness in the surface of the second web W**2**, and variation in the thickness of the second web W**2** can be measured under favorable conditions.

2. Embodiment 2

FIG. **11** is a perspective view of the distributor **60**A in a second embodiment of the invention.

This distributor **60**A is used in the sheet manufacturing apparatus **100** instead of the distributor **60** described above. The distributor **60**A has a housing **63** configured as described in the distributor **60** above, causes mixture MX to precipitate from the distribution drum **61** inside the housing **63** and accumulate on the mesh belt **72**, forming a second web W**2**.

This distributor **60**A has an air flow restrictor **811** disposed to branch conduit **54***c*, and another air flow restrictor **812** disposed to branch conduit **54***d*, and does not have the air current adjustor **801** shown in FIG. **2**. In other words, the distributor **60**A uses air flow restrictors **811** and **812** instead of an air current adjustor **801**. Parts of the distributor **60**A other than the air flow restrictors **811** and **812** are the same as the distributor **60** described above, are therefore identified by the same reference numerals, and further description thereof is omitted.

The airflow restrictor **811** disposed to branch conduit **54***c* operates as controlled by the controller **110**, and changes the sectional area of the path through which the conveyance current M2 flows inside the branch conduit **54***c*.

FIG. **12** is a section view of the configuration of the air flow restrictor **811** through line A-A in FIG. **11**.

As shown in FIG. **12**, the air flow restrictor **811** has a shutter **813**. The shutter **813** in this example is a plate that moves bidirectionally in the directions indicated by the arrow MV. The shutter **813** is a rigid panel with strength sufficient to obstruct at least the passage of conveyance current M**2**.

The range of shutter **813** movement overlaps the branch conduit **54***c*. When the shutter **813** overlaps the branch conduit **54***c*, the conveyance current M**2** cannot pass through the part **54***ca* blocked by the shutter **813**. More specifically, the shutter **813** limits the sectional area of the path of the conveyance current M2 through the branch conduit **54***c*. By changing the position of the shutter **813**, the sectional area of the path through the branch conduit **54***c* can be changed.

In the configuration shown in the example in FIG. **12**, the shutter **813** can move to any position from position **813***a* where the shutter **813** is not overlapping (closing) any part of the branch conduit **54***c*, and position **813***b* where the shutter **813** completely closes the branch conduit **54***c*. In this example, the maximum sectional area of the path of the conveyance current M2 through the air flow restrictor **811** is the same as the sectional area of the branch conduit **54***c*, and the minimum is zero.

The air flow restrictor **811** can move the shutter **813** by an actuator not shown. The actuator of the air flow restrictor **811** is equivalent to the air flow adjustor **154** shown in FIG. **9**. The air flow restrictor **811** can therefore change the sectional area of the path through the branch conduit **54***c* by moving the shutter **813** as controlled by the controller **110**.

The other air flow restrictor **812** is configured identically to air flow restrictor **811**. The air flow restrictor **812** can change the sectional area of the path of the conveyance current M3 through the branch conduit **54***d* as controlled by the controller **110**.

By changing the sectional area of the paths of the air flow restrictors **811** and **812**, the flow resistance of the conveyance currents M2 and M3 through the branch conduits **54***c* and **54***d* also changes. A difference in the flow resistance of the conveyance current M2 and conveyance current M3 produces a difference in the size of conveyance current M2 and conveyance current M3 flowing from the conveyance current M1. More specifically, by adjusting the ratio between the sectional area of the path through air flow restrictor **811**, and the sectional area of the path through air flow restrictor **812**, the balance between the size of conveyance current M2 and conveyance current M3 can be adjusted.

The airflow restrictors **811** and **812** in this configuration are examples of an air flow adjustor and an adjustor in the accompanying claims.

The distributor **60**A configured as described above has the same operational effect as the distributor **60** in the first embodiment.

In addition, in a sheet manufacturing apparatus **100** employing the web forming device, web processing device, and fibrous feedstock recycling device of the invention, the controller **110** controls the air flow restrictors **811** and air flow restrictor **812** in the configuration using the distributor **60**A. This controls the amount of mixture MX supplied from the air lines **57***a* and **57***b* to the distributor **60**. More specifically, the distribution of mixture MX along the width direction WD in the distribution drum **61** can be adjusted by controlling the air flow restrictors **811** and **812**. The distribution of the thickness of the second web W2 can therefore be desirably adjusted.

3. Embodiment 3

FIG. **13** is a perspective view of the distributor **60**B in a third embodiment of the invention, and FIG. **14** is a function block diagram of the sheet manufacturing apparatus **100** according to the third embodiment of the invention.

This distributor **60**B is used in the sheet manufacturing apparatus **100** instead of the distributor **60** described above. The distributor **60**B has a housing **63** configured as described in the distributor **60** above, and causes mixture MX to precipitate from the distribution drum **61** inside the housing **63** and accumulate on the mesh belt **72**, forming a second web W2.

This distributor **60**B uses air supply fans **821** and **822** instead of air flow restrictors **811** and **812** described in the second embodiment above. Parts of the distributor **60**B other than the air supply fans **821** and **822** are the same as the distributor **60** described above, are therefore identified by the same reference numerals, and further description thereof is omitted.

Air supply fan **821** is a fan disposed to air line **57***a* for blowing air from outside the distributor **60**B into the air line **57***a*. The air supply fan **821** has an inlet **821***a* that opens to the outside of the distributor **60**B, and supplies air suctioned from the inlet **821***a* into the housing **63**.

Air supply fan **822** s a fan disposed to air line **57***b* for blowing air from outside the distributor **60**B into the air line **57***b*. The air supply fan **822** has an inlet **822***a* that opens to the outside of the distributor **60**B, and supplies air suctioned from the inlet **822***a* into the housing **63**.

The air supply fans **821** and **822** both push air in the direction to the distribution drum **61**. Because the air current supplied by the air supply fans **821** and **822** is air pulled from outside the housing **63**, the air current does not carry any mixture MX. In this embodiment, a configuration that supplies humidified air such as described in the first embodiment may be disposed outside of the housing **63**, for example.

As shown in FIG. **14**, air supply fan **821** and air supply fan **822** are connected to a controller **110**. The controller **110** controls turning rotation of the fan motor not shown of the air supply fan **821** on and off. Further preferably, the controller **110** also controls the rotational speed of the fan motor of the air supply fan **821**.

The controller **110** also controls turning rotation of the fan motor not shown of air supply fan **822** on and off. Further preferably, the controller **110** also controls the rotational speed of the fan motor of the air supply fan **822**.

The air current supplied by the air supply fan **821** flows with the conveyance current M2 into the distribution drum **61**. The air current supplied by the air supply fan **822** flows with the conveyance current M3 into the distribution drum **61**. As a result, the volume and/or the air speed of the air currents flowing from the right R and left L sides into the distribution drum **61** changes according to the air current supplied by air supply fan **821** and the air current supplied by air supply fan **822**.

The air currents from the air supply fans **821** and **822** also change the amount of air not carrying mixture MX that flows into the distribution drum **61**.

By the controller **110** controlling the air supply fans **821** and **822**, these changes can be used to adjust the distribution of the mixture MX in the width direction WD inside the distribution drum **61**. As a result, the air supply fans **821** and **822** function as air flow adjustors in the invention, and adjust the distribution in the width direction WD of the mixture MX falling from the distribution drum **61** onto the mesh belt **72**. This adjustment can be controlled by the controller **110** controlling turning the air supply fan **821** and air supply fan **822** on and off. In addition, the controller **110** can adjust the distribution in fine increments by controlling the speed of air supply fan **821** and air supply fan **822** separately.

The distributor **60**B thus comprised has the same operational effect as the distributor **60** of the first embodiment.

In addition, in a sheet manufacturing apparatus **100** employing the web forming device, web processing device, and fibrous feedstock recycling device of the invention, the controller **110** controls the air supply fan **821** and air supply fan **822** in the configuration using the distributor **60**B. As a result, the distribution of mixture MX falling from the distribution drum **61** onto the mesh belt **72** can be adjusted along the width direction WD, and the distribution of the thickness of the second web W2 can therefore be desirably adjusted.

4. Embodiment 4

FIG. **15** is a perspective view of the distributor **60**C in a fourth embodiment of the invention.

This distributor **60**C is used in the sheet manufacturing apparatus **100** instead of the distributor **60** described above. The distributor **60**C has a housing **63** configured as described in the distributor **60** above, and causes mixture

MX to precipitate from the distribution drum **61** inside the housing **63** and accumulate on the mesh belt **72**, forming a second web W**2**.

This distributor **60**C is configured without the air flow restrictor **811** of the distributor **60** described above. The distributor **60**C also has suction mechanisms **76***a* and **76***b* disposed below the mesh belt **72** to suction air through the mesh belt **72**. Parts of the distributor **60**C other than the suction mechanisms **76***a* and **76***b* are the same as the distributor **60** described above, are therefore identified by the same reference numerals, and further description thereof is omitted.

Suction mechanism **76***a* and suction mechanism **76***b* are disposed side by side on the width direction WD below the mesh belt **72**.

Suction mechanism **76***a* is connected to a third dust collector **67***a* through a conduit **66***a*. The third dust collector **67***a* is connected to a third collection blower **68***a*. Like the second collection blower **68** described above, the third collection blower **68***a* suctions air as controlled by the controller **110**, and discharges through a discharge line to the outside of the sheet manufacturing apparatus **100**. The third dust collector **67***a* is a filter that traps fiber and particles carried in the air current suctioned from the distributor **60**C through the suction mechanism **76***a*.

Suction mechanism **76***b* is connected to a fourth dust collector **67***b* through a conduit **66***b*. The fourth dust collector **67***b* is connected to a fourth collection blower **68***b*. Like the second collection blower **68** described above, the fourth collection blower **68***b* suctions air as controlled by the controller **110**, and discharges through a discharge line to the outside of the sheet manufacturing apparatus **100**. The fourth dust collector **67***b* is a filter that traps fiber and particles carried in the air current suctioned from the distributor **60**C through the suction mechanism **76***b*.

The third collection blower **68***a* and fourth collection blower **68***b* are controlled separately by the controller **110**. The controller **110** controls turning rotation of the blower motor not shown of the third collection blower **68***a* on and off. Further preferably, the controller **110** also controls the rotational speed of the blower motor of the third collection blower **68***a*.

The controller **110** ALSO controls turning rotation of the blower motor not shown of the second collection blower **68** on and off. Further preferably, the controller **110** also controls the rotational speed of the blower motor of the fourth collection blower **68***b*.

The rotational speed of the blower motor of the third collection blower **68***a* determines the amount and speed of the left-side suction current, that is, the suction current on the left side of the width direction WD of the mesh belt **72**.

Likewise, the rotational speed of the blower motor of the fourth collection blower **68***b* determines the amount and speed of the right-side suction current, that is, the suction current on the right side of the width direction WD of the mesh belt **72**.

Therefore, by controlling the rotational speed of the blower motors of the third collection blower **68***a* and fourth collection blower **68***b*, the controller **110** can change the balance in the width direction WD between the suction currents flowing down from the distribution drum **61**. Changing this balance changes the distribution in the width direction WD of the mixture MX falling from the distribution drum **61**.

As a result, the third collection blower **68***a* and fourth collection blower **68***b* function as air flow adjustors in the invention, and adjust the distribution in the width direction WD of the mixture MX falling from the distribution drum **61** onto the mesh belt **72**. This adjustment can be controlled by the controller **110** controlling turning the third collection blower **68***a* and fourth collection blower **68***b* on and off. In addition, the controller **110** can adjust the distribution in fine increments by controlling the speed of third collection blower **68***a* and fourth collection blower **68***b* separately.

In this configuration, the suction mechanisms **76***a* and **76***b* function as air flow adjustors.

The distributor **60**C thus comprised has the same operational effect as the distributor **60** of the first embodiment.

In addition, in a sheet manufacturing apparatus **100** employing the web forming device, web processing device, and fibrous feedstock recycling device of the invention, the controller **110** controls the third collection blower **68***a* and fourth collection blower **68***b* in the configuration using the distributor **60**C. As a result, the distribution of mixture MX falling from the distribution drum **61** onto the mesh belt **72** can be adjusted along the width direction WD, and the distribution of the thickness of the second web W**2** can therefore be desirably adjusted.

The fourth embodiment of the invention describes a configuration that suctions by means of suction mechanisms **76***a* and **76***b* below the mesh belt **72**, but the invention is not so limited. For example, there may be three or more suction mechanisms displayed below the mesh belt **72**, and the volume and/or speed of the currents suctioned by these suction mechanisms may be separately controlled by the controller **110**.

5. Embodiment 5

FIG. **16** is a perspective view of the distributor **60**D in a fifth embodiment of the invention, and FIG. **17** is a function block diagram of a sheet manufacturing apparatus **100** according to the fifth embodiment of the invention.

This distributor **60**D is used in the sheet manufacturing apparatus **100** instead of the distributor **60** described above. The distributor **60**D has a housing **63** configured as described in the distributor **60** above, and causes the mixture MX to precipitate from the distribution drum **61** inside the housing **63** and accumulate on the mesh belt **72**, forming a second web W**2**.

This distributor **60**D is configured with air flow restrictors **841** and **851** instead of the air flow restrictor **811** of the first embodiment described above. Parts of the distributor **60**C other than the air flow restrictors **841** and **851** are the same as the distributor **60** described above, are therefore identified by the same reference numerals, and further description thereof is omitted.

Air flow restrictor **841** is disposed to the right wall **633**, and has an opening **842** that connects the outside of the housing **63** to the internal space **62**.

Air flow restrictor **851** is disposed to the left wall **634**, and has an opening **852** that connects the outside of the housing **63** to the internal space **62**. This air flow restrictor **851** also has a movable door **853** that opens and closes the opening **852**.

The movable door **853** is a door that can move between a position completely closing the opening **852**, and a position maximally opening the opening **852**, and is driven by an opening adjustor **854**.

The opening adjustor **854** is an actuator that moves the movable door **853**, operates as controlled by the controller **110**, and operates the movable door **853**.

The other air flow restrictor **841** is not shown in the figure, but has a movable door identical to the movable door **853**, and drives the movable door by means of the opening adjustor **844** shown in FIG. **17**. The opening adjustor **844** is an actuator configured identically to opening adjustor **854**.

When the opening **842** is not closed, outside air A**1** is suctioned into the internal space **62** from outside the housing **63** by suction produced by the suction mechanism **76**.

Likewise, when opening **852** is not closed, outside air A**1** is suctioned into the internal space **62** from outside the housing **63** by suction produced by the suction mechanism **76**.

The volume and/or speed of the outside air A**1** suctioned through the openings **842**, **852** is determined by the width (size) of the openings **842**, **852**. More specifically, if the size of the openings **842**, **852** changes, the flow resistance to the flow of outside air A**1** through the openings **842**, **852** changes.

For example, suppose the suction of the suction mechanism **76** remains constant, and the volume of the conveyance currents M2 and M3 supplied from the conduit **54** to the housing **63** remains constant. In this case, depending on the magnitude of the flow resistance through the openings **842**, **852**, the volume and/or speed of the outside air A**1** suctioned from the openings **842**, **852** changes.

The outside air A**1** flowing from the openings **842**, **852** does not contain the mixture MX. In this embodiment, a configuration that supplies humidified air such as described in the first embodiment may be disposed outside of the housing **63**, for example, and the outside air A**1** may be humidified air.

As shown in FIG. **17**, the opening adjustors **844** and **854** are connected to a controller **110**. The controller **110** separately controls the opening adjustors **844** and **854** to move the movable door of the air flow restrictor **841** and movable door **853**. The width of the opening **842** and the width of the opening **852** can therefore be separately adjusted.

When the widths of the openings **842**, **852** are adjusted, the volume and/or speed of the outside air A**1** flowing from the right R and left R to the distribution drum **61** change.

The outside air A**1** passing through opening **842** produces an air current from the right R flowing downward through the internal space **62** to the space toward the mesh belt **72** to which the mixture MX descends.

The outside air A**1** passing through opening **852** likewise produces an air current from the left L flowing downward through the internal space **62** to the space toward the mesh belt **72** to which the mixture MX descends.

By changing the ratio between the outside air A**1** flowing in from the opening **842** and the outside air A**1** flowing in from the opening **852**, the distribution of the mixture MX falling to the mesh belt **72** can be adjusted along the width direction WD. This adjustment can be made by the controller **110** driving the opening adjustors **844** and **854** to appropriately open and close the openings **842**, **852** as described above.

By the controller **110** adjusting the size (width) of the open area of the openings **842**, **852**, the distribution of the mixture MX accumulated in the width direction WD on the mesh belt **72** can be adjusted more precisely.

The distribution of the amount of mixture MX, that is, the distribution of the accumulated thickness, in the width direction WD of the second web W2 accumulated on the mesh belt **72** can thus be controlled by the controller **110** in the fifth embodiment of the invention.

In this configuration, the air flow restrictors **841** and **851** function as air flow adjustors.

The distributor **60**D thus comprised has the same operational effect as the distributor **60** of the first embodiment.

In addition, in a sheet manufacturing apparatus **100** employing the web forming device, web processing device, and fibrous feedstock recycling device of the invention, the controller **110** controls the opening adjustors **844** and **854** in the configuration using the distributor **60**D. As a result, the distribution of mixture MX falling from the distribution drum **61** onto the mesh belt **72** along the width direction WD can be adjusted, and the distribution of the thickness of the second web W**2** can therefore be desirably adjusted.

7. Other Embodiments

The embodiments described above are only examples of specific embodiments of the invention as described in the accompanying claims, do not limit the invention, and can be varied in many ways as described below without departing from the scope and spirit of the invention as described in the accompanying claims.

The foregoing embodiments describe configurations that measure the thickness of the second web W**2** by a measurement device **400** at a position downstream in the conveyance direction F**1** from the position where the second web W**2** is compressed by a roller unit **650**, but the invention is not so limited. For example, the measurement device **400** may measure the thickness of the second web W**2** while the second web W**2** is being compressed by the roller unit **650**.

The foregoing embodiments describe configurations in which the measurement device **400** has multiple optical detectors **401**, and based on the measurements taken by each optical detector **401**, the controller **110** determines the distribution of the thickness of the second web W**2** in the width direction WD, but the invention is not so limited.

For example, the roller unit **650** may be configured with the second seal roller **65** supported to tilt according the distribution of the thickness of the second web W**2** in the width direction WD, and the measurement device **400** configured with sensors that detect the angle of this inclination. In this case, the distribution of the thickness of the second web W**2** in the width direction WD can be measured by the one or multiple sensors that detect the slope of the second seal roller **65**.

The foregoing embodiments also describe as configurations for compressing the second web W**2** configurations that apply pressure by means of a second seal roller **65**, but the invention is not so limited. For example, the second web W**2** may be compressed by pushing a flat pressure member against the second web W**2** from above the mesh belt **72**. A suction mechanism that suctions air from below the mesh belt **72**, and produces an air flow passing through the mesh belt **72** and second web W**2** may also be provided. In this event, the second web W**2** is compressed by the flow resistance of the air current flowing down through the second web W**2** from above.

The materials and other details about the distributors **60**, **60**A, **60**B, **60**C, and **60**D described in the foregoing embodiments may also be appropriately modified as desired.

Of the air current adjustor **801**, air flow restrictors **811** and **812**, air supply fans **821** and **822**, air flow restrictors **841** and **851**, and suction mechanisms **76***a* and **76***b* described above, configurations having multiple mechanisms desirably combined in the distributor **60** are also conceivable.

The foregoing embodiments describe, as a fibrous feedstock recycling device according to the invention, a dry process sheet manufacturing apparatus **100** that acquires material by defibrating feedstock in air, and uses the defibrated material to manufacture sheets S. However, the invention is not so limited, and may also be applied to electrostatic sheet manufacturing apparatuses that attract material containing fiber defibrated in air to the surface of a drum by static attraction, and manufacture the material attracted to the drum into sheets.

The invention being thus described, it will be obvious that it may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

The entire disclosure of Japanese Patent Application No: 2018-128782, filed Jul. 6, 2018 is expressly incorporated by reference herein.

What is claimed is:

1. A web forming device comprising:

a distributor configured to disperse material containing fiber;

an accumulator configured to accumulate the material dispersed by the distributor and form a web;

a conveyor configured to convey the web in a first direction;

a compression device configured to compress the web conveyed in the first direction;

a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the compression device, or after the web is compressed by the compression device; and

a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web.

2. The web forming device described in claim **1**, further comprising:

a plurality of measurement devices disposed along the second direction.

3. The web forming device described in claim **1**, further comprising:

a plurality of material suppliers that supply the material to the distributor; and

an adjustor configured to adjust an amount of the material supplied to the distributor from the plurality of suppliers as controlled by the controller.

4. The web forming device described in claim **1**, wherein:

the distributor has a distribution drum that disperses the material, and a case surrounding a space between the distribution drum and the accumulator, and disperses the material in air inside the case, and

an air flow adjustor configured to adjust an air flow in the second direction inside the case as controlled by the controller.

5. A web processing device comprising:

a distributor configured to disperse material containing fiber;

an accumulator configured to accumulate the material dispersed by the distributor and form a web;

a conveyor configured to convey the web in a first direction;

a first compression device configured to compress the web conveyed in the first direction;

a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the first compression device, or after the web is compressed by the first compression device;

a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web; and

a second compression device configured to compress the web after measurement by the measurement device and compression by the first compression device.

6. The web processing device described in claim **5**, wherein:

the first compression device compresses the web with less pressure than the second compression device.

7. A fibrous feedstock recycling device comprising:

a defibrator configured to defibrate feedstock containing fiber;

a distributor configured to distribute defibrated material defibrated by the defibrator;

an accumulator configured to accumulate the defibrated material distributed by the distributor, and form a web;

a conveyor configured to convey the web in a first direction;

a first compression device configured to compress the web conveyed in the first direction;

a measurement device configured to measure a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed by the first compression device, or after the web is compressed by the first compression device;

a controller configured to compare measurements from the measurement device with a previously set thickness distribution, and control the thickness distribution of the web; and

a second compression device configured to compress the web after measurement by the measurement device and compression by the first compression device.

8. A web forming method, comprising:

distributing material containing fiber;

accumulating the dispersed material and forming a web;

conveying the web in a first direction;

measuring a thickness distribution of the web in a second direction intersecting the first direction while the web is being compressed, or after the web is compressed; and

comparing measurement results with a set thickness distribution, and control the thickness distribution of the web.

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